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CONTENTS

The Advancing Pendulum of Biological Thought: PROFESSOR C. C. NUTTING 403

The Natural Charges of Metals: PROFESSOR FERNANDO SANFORD 409

The Fire and the Museum at Ottawa: HARLAN I. SMITH 415

Robert James Davidson: DR. FRANK K. CAMERON 418

The Rockefeller Foundation and the General Education Board 419

Centennial of the Coast and Geodetic Survey .. 420

Scientific Notes and News 422

University and Educational News 425

Discussion and Correspondence:—
Mesozoic Pathology and Bacteriology: DR. ROY L. MOODIE. *Efficient Summer Vacations:* DR. LANCASTER D. BURLING. *German Geologists and the War:* WALTER L. BARROWS 425

Scientific Books:—
Davenport's The Feebly Inhibited: PROFESSOR EDWARD L. THORNDIKE. *Publications of the Nutrition Laboratory of the Carnegie Institution:* PROFESSOR YANDELL HENDERSON. *Herrick's Introduction to Neurology:* DR. P. G. STILES 427

Special Articles:—
The Botanical Identity of Lignum nephriticum: DR. W. E. SAFFORD. *Preliminary Studies on Heated Soils:* JAMES JOHNSON. *The Interferences of Parallel and Crossed Rays:* PROFESSOR CARL BARUS 432

Societies and Academies:—
The Botanical Society of Washington: DR. W. E. SAFFORD. *The Biological Society of Washington:* DR. M. W. LYON, JR. 436

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THE ADVANCING PENDULUM OF BIOLOGICAL THOUGHT

THE specialist often finds it interesting, and sometimes profitable, to pause in the intensive pursuit of his own little field and take time to contemplate the general trend of thought in biological science.

In my own case it is often borne in upon me that the zoological public is little interested in the group of animals, the Hydroida, with which I work, and it is a positive relief to contemplate the broader aspects of the field of natural science.

Let this, then, be my excuse for presenting a paper that is non-technical in form and more of the nature of a general survey of the path along which we have traveled in the acquisition of general biological truth.

Upon taking such a survey it at once becomes evident that progress has been made along a sharply zigzag road, with successive swings to right and left, involving abrupt changes of accepted theories. In fact this path is that which would be traced by a pendulograph as made by an advancing pendulum. The actual movements would be mainly to the right and left of a median line representing actual progress, but each swing of the pendulum would make a slight but sure advance along that median line.

The idea is not really new and has been incidentally touched upon by various writers; but it seems to me that it would be profitable to consider with some care a few of the comparatively recent swings of the pendulum, to note the advance made by each, and possibly to arrive at some general

statements as to our attitude toward the work and our fellow workers.

For this purpose let us give our attention to some of the more important swings of our pendulum that have taken place since the appearance of that epochal event, the appearance of Darwin's "Origin of Species by Means of Natural Selection."

As is usually the case, the workers immediately following Darwin were inclined to outdo their leader, to out-Darwin Darwin and to overwork the theory which he advanced, making natural selection the sole efficient cause of the origin of species.

By far the ablest and most prominent writer who thus swung the pendulum away from the sane and reasonable path along which Darwin had advanced was August Weismann, who startled the world with his declaration that acquired characters were not inherited, and advanced the theory of the continuity and stability of the germplasm. This fascinating and minutely worked out scheme for advancing and clenching the argument for natural selection found many opponents and many ardent advocates. The battle was raged round the chromosomes as the center, and their intricacy and theoretical details were elaborated by Weismann and others until germplasm and somatoplasm, determinants, ids and idents were the stock in trade of every callow as well as learned biologist, in spite of the fact that these latter were unknown and unknowable. Indeed the whole fabric bid fair to break down by the very complexity of the concepts borne of an endeavor to imagine a machinery adequate to account for the increasingly intricate requirements of the known facts of heredity and evolution.

At the present time these terms have been in part abandoned and in part supplanted by others, but the pendulum had not only swung far to one side, but had actually advanced. This advance is probably best shown in the almost universal acquiescence at present in the idea that acquired characters are, at best, seldom inherited and that such cases are too few to be seriously considered as affecting greatly the trend of evolution.

But another, and perhaps more important gain was in the impetus given to the study of cytology, particularly the behavior of the nucleus, and the consequent marvelous improvement in the technique of the study of the chromosomes and the fascinating phenomena of fertilization and cell division. These are indeed important gains, however much the details of the Weismannian doctrine may be modified by subsequent discoveries.

But suddenly the pendulum began to swing the other way. Theodore Eimer in Germany vigorously, if somewhat unwisely, attacked the position of Weismann, being followed by others in Europe and by many of our own countrymen led by our famous paleontologist, Professor E. D. Cope. These latter formed what was then known as the "American School" of Neo-Lamarckians, who believed that acquired characters were inherited and that variations appear in definite directions and "are caused by the interaction of the organic being and its environment."

Few of the younger naturalists present can have any conception of the heat of the battle waged between the Neo-Darwinian and Neo-Lamarckian schools in the last decade of the nineteenth century. Professor Cope himself was a born controversialist and one of the most trenchant and quick-witted debaters among American biologists. Many of the older zoologists will picture to themselves his alert pose, his square-cut chin and the light of battle in his eye as he debated the question in meetings of this association; and discussed cat-

agenesis, kinetogenesis, physiogenesis, bathmogenesis and mnemogenesis.

The advance made by this Neo-Lamarckian swing of the pendulum was not so great nor so sure as its immediate predecessor. The battle in the main went against the Neo-Lamarckians. But they were a notable company, embracing many of the foremost names in the biological roster of that time. Such names as Hyatt, Cope, Dall, H. F. Osborn, Packard, Riley, Eigenmann and many others are significant of the standing of that notable group.

But there was some advance made by the Neo-Lamarckian swing. Cope's "law of the unspecialized" was a direct contribution to our understanding of the course, if not the cause, of organic evolution in its broader aspects; and Eigenmann's argument for the inheritance of acquired characters drawn from his masterly studies of blind vertebrates has not, so far as I am aware, been successfully controverted. To this day a very respectable body of zoologists are inclined to feel, deep down in their consciousness, that, as Geddes and Thomson say:

> It is idle to say that what living creatures do or fail to do has no racial importance.[1]

The remaining swing of the pendulum that demands our attention has just reached its maximum, and may well be designated as the "Mendelian swing." Not entirely Mendelian, either, but partly de Vriesian. This was in a direction tending to a wide departure from the position that had been taken by practically all workers since Darwin; *i. e.*, that natural selection had worked mainly, if not exclusively, by the gradual summation of small but appreciable individual variations. De Vries, with his famous evening primrose, had demonstrated, to his own satisfaction at least, that species arise by sudden mutations and thus sprung full-orbed into being and that ordinary variations never produced species by their summation. He claimed, however, that his theory was a direct contribution to Darwin's theory of natural selection.

At about the same time that de Vries was working with his primroses, the Austrian monk, Mendel, was working with sweet peas and made discoveries whose importance was not recognized until, in 1900, his results were verified by de Vries, Bateson and others in Europe and Castle, Davenport and others (a little later) in America. This was another epochal event in biological advance, and the scientific world was soon plunged into a warm discussion of the "Mendelian Law." Dominant and recessive, segregation, homozygotes and heterozygotes, determiners and factors, genotypes and phenotypes, were the order of the day. But worse was still to come. Factors of four kinds, determiners of three kinds, potencies of three kinds; then inhibitors to explain why the thing did not work. Allelomorphs, sex-limited inheritance and side chains, sweet peas and white mice, guinea-pigs and chickens, filled the circumambiant atmosphere. Biological laymen endeavored to steady their whirling brains while filled with admiration for the warm imagination of these new prophets. Intricate genealogical tables of new and fearful mien stared at us from blackboard, chart and printed page, and we tried, with indifferent success, to look intelligent.

Bateson, in his address as president of the British Association, capped the climax when he added to the world-stupefying clamor of the opening war with the following verbal bomb:

> We must begin seriously to consider whether the course of evolution can at all reasonably be represented as an unpacking of an original complex

[1] "Evolution," 1911, p. 201.

which contained within itself the whole range of diversity which living things present.

Man simply an unpacked amœba! The mammal but a released protozoan! *Amœba proteus* a Prometheus bound! Not only the myriads of factors which represent "the whole range of diversity which living things present," but also the inhibitor for each waiting to assist in the unpacking and the thing that did the unpacking, all encompassed within the confines of a primordial cell! Also an implied super-Mosaic Diety that foresaw all this and did the original packing. The good old Presbyterian doctrine of foreordination absolutely outdone at last! Regeneration in its original theological sense biologically affirmed! And why not? Since we are told that unchastity in women is a unit character, chastity is attained by the miraculous release brought about by an inhibitor that is brought to a sense of its sinfulness and abandons its wicked ways; and the poor woman is started on the way to total sanctification!

Surely, we have now witnessed the extreme swing of the pendulum along the Mendelian path, and the reverse swing is due.

But no one will deny, all jesting aside, that real progress has been gained by the Mendelian swing, nor that this doctrine has contributed a distinct advance in our biological thinking. Few will fail to acknowledge that the factorial hypothesis explains much that has been obscure; that dominant and recessive are terms that will endure; that mutation will solve many a perplexing problem, possibly not of species in a state of nature, but surely of varieties under cultivation and of hybridization.

The idea of rhythm or swing has been in the minds of many thinkers. It is at the center of biological activities. Geddes and Thomson, in speaking of the historical oscillations between the mechanistic interpretation of the living organism and the vitalistic appreciation of it, say:

Now it is a machine and again it is a spirit, now an automaton and again a free agent, now an engine and again an entelechy. The pendulum of thought continues to swing.[2]

Numerous illustrations of this biological rhythm will occur to each of us. Cell division and conjugation, medusa and hydroid colony, growth and reproduction, anabolism and katabolism, life and death. These are all swings of the pendulum. But there is also a steady advance. The life of the individual includes both swings, but there is also a real advance in the complexity of the species; and from these advances new species arise, whether by mutation or by the accumulation of variations.

The question as to what causes the advance will be answered when we at last find the real cause of evolution itself.

In contemplating this swinging and advancing pendulum of thought certain fundamental principles of wide application come to occupy the focus of attention:

1. While the pendulum swings regularly to right and left, it never actually retraces its course; but advances with each swing. There is a net gain which records definite progress, and this progress is, in general, along the line of evolution.

2. The extreme of each swing is actually further away from the real path of progress than the mean, away from the main direction of advance. The extremest is almost invariably wrong, in the main. He lets his imagination run away with him and carry him much too far, and the wise man will not follow him, but stops far short of the extreme and usually actually pulls back. This is the really valuable service of the conservative mass of thinkers in any

[2] "Evolution," 1911, p. 202.

province of thought; they tend to a return to the mean of wisdom and sanity. To change our simile for a moment, the extremist carries the ball far to the left or right in an end run; but he advances it somewhat, and the conservative mass of his colleagues brings the ball back to the center of the field and more directly in front of the goal.

It is almost hopeless to-day to look for a Weismannian in the extreme sense, but there is a practical acceptance of the idea of the continuity and stability of the germplasm. Probably no one now would give adherence to Cope's complete program, but many believe that, somehow, acquired characters play a real part in the advance of species. In my opinion, too, there are very few indeed who would frankly subscribe to the extreme of Bateson's doctrine regarding the unpacking process, but there are very many who admit that the Mendelian law is a very important thing in heredity, whether it really advances evolution or not.

3. We should be exceedingly hesitant in unreservedly condemning the leaders of the past, or the theories they advanced. Each one of them has done good service and each has been the vehicle of some important truth. Perhaps none of the theories advanced by Darwin has been so mercilessly ridiculed as that of pangenesis. Yet I find in one of the most recent utterances of T. H. Morgan the following:

> There is extensive evidence from cytology, experimental embryology and regeneration to show that all the different cells of the body receive the same hereditary factors.[3]

The swing of the pendulum back from the extreme position taken by Bateson has surely commenced, as the following quotations will show.

Castle, one of the leading American authors in Mendelianism, says:

> The more carefully we scrutinize the mutation theory the more serious do our doubts become, whether it is a secure foundation to build on, and again whether sport variation has had any part in the evolution of species is accordingly very doubtful.[4]

The veteran zoologist, Wm. H. Dall, says, in commenting on Bateson's address:

> We may admit the value of the Mendelian discovery in its relation to low and relatively simple organisms, like plants, and also that in higher organisms Mendelian effects can sometimes be traced, but that unbridled hypothesis should be permitted to cover our colossal ignorance is not what we expect from such a source. When the observed facts flatly contradict a hypothesis a truly scientific expositor says "I can not account for it," and does not cover up (to the lay mind) his ignorance by the phrase of "an inhibitory factor."[5]

No more honored name is at present on the roster of American biologists than that of E. B. Wilson, and the following quotation from him has a weight that all must recognize:

> And yet, as far as the principle is concerned, I am bound to make confession of my doubts whether any existing discussion of the problem affords more food for reflection, even to-day, than that contained in the sixth and seventh chapters of the "Origin of Species" and elsewhere in the works of Darwin.

The next swing of the pendulum lies in the immediate future, and we know not what it will bring forth; but we do know that it will be the means of a new advance along the road to a better understanding of nature's methods.

In the meantime, what should be the attitude of the systematist? Bateson would say that he is out of the game altogether, as the following quotation will show:

[3] "Mechanism of Mendelian Heredity," 1915, p. 42.

[4] SCIENCE, Vol. XLI., p. 98.

[5] SCIENCE, 1914, p. 245.

> Their (the systematists') business is purely that of the cataloguer, and beyond that they can not go.[6]

After full and calm reflection it seems to me that it is not too much to say that this utterance is proof positive that its author is hardly competent to pass an opinion on the work of his colleagues in other fields of biology however great his achievements in his own province. Castle expresses the following opinion:

> It is easy to dispose of the work of the systematist by assuming that he does not know his business, but is it wise to do so?[7]

As a matter of fact it seems to me that the systematist is affected not at all by Mendelianism. His species must be limited on phenotypic grounds alone, because the external appearance and morphology are all that can possibly be known of all but an infinitesimal fraction of the hundreds of thousands of species that must be dealt with. He cares little about what is done with domesticated animals, nor is he greatly interested in forms produced under abnormal conditions of captivity, cross fertilization or other forms of enforced biological immoralities. Of the 10,000 species of modern birds, for instance, how many can be established on factorial grounds? When it comes to the half million or so of insects, a few score, or perhaps hundreds of species might be worked out in the laboratory by Mendelian rules; but the laboratory conditions are usually highly unnatural, and it is safe to say that the results would be endless contradictions and confusion worse confounded; and the remaining hundreds of thousands of species would still have to be dealt with phenotypically or not at all.

So, too, with the innumerable marine forms of invertebrates, a single order of which is a man's job for a life-time, if he is to distinguish them phenotypically alone. The task is absolutely hopeless if treated genotypically.

The systematist knows that species differ from each other in very numerous small characters, and that, even if they would lend themselves to factorial analysis, the result would be much more perplexing than the present system which continually evokes the wrath of our nonsystematic colleagues.

Nor will our work be exclusively, or even mainly, that of the cataloguer. With the aid of our friends the morphologists, embryologists and paleontologists we will continue to unravel the tangled skein of descent; and our opinion will be valued in proportion to the honesty, patience and skill which we bring to our work, just as it always has been.

And so, I think, we can rest easy in the continuance of our job. Meanwhile we can greatly admire the man who busies himself with the microcosm of the cell, and bid him God-speed. We can contemplate with sympathetic delight the experimental zoologist as he shakes the eggs of the sea urchin and salts them with various kinds of salt.

We can even derive pleasure and much entertainment from the marvelous feats of our ultra-Mendelian friend, in full assurance that he will produce a factor that will meet every possible requirement; and that if he doesn't produce the factor he will have an inhibitor at hand to explain why the thing doesn't work. And we can rest calm in the faith that, if neither factor nor inhibitor is forthcoming, he will in no wise be abashed, but will calmly declare the form under scrutiny to be nothing but a fluctuating variety, and will smilingly cast it into the discard along with the systematist, who will just as smilingly proceed with his customary activities.

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[6] SCIENCE, August 14, 1914, p. 245.

[7] SCIENCE, XLI., p. 98.

ON THE NATURAL CHARGES OF METALS[1]

In 1789 Bennett discovered that when two similar, insulated brass plates are placed very close together and parallel to each other and are simultaneously touched with pieces of different metal held in the hands they become charged relative to each other, and oppositely charged relative to the earth. Bennett gave the results of touching his plates with six different pairs of metals, and thus laid the foundation for what later came to be called the Volta contact series of metals. Bennett concluded as the result of his experiments that different substances have "a greater or less affinity with the electrical fluid," and he published a series of "Experiments on the Adhesive Electricity of Metals and Other Conducting Substances."

Bennett also tried the effect of touching one brass plate with a single metal while the other plate was parallel and very close to it but was joined to earth, and he found that his brass plate would take a positive charge when touched with lead ore, gold, silver, copper, brass, regulus of antimony, bismuth, tutenag, mercury and various kinds of wood and stone; but that it would take a negative charge from zinc and tin.

Six years later (in 1795) Cavallo published the results of a series of experiments on contact electrification. Cavallo placed a tin plate upon insulating supports and dropped a piece of metal upon it from the hand or from tongs or a spoon. He then tilted the tin plate and allowed the metal to slide off it, after which it was picked up and dropped onto the plate again. By sufficient repetition of this process, the plate became so highly electrified that the nature of its charge could be determined. Cavallo tried the effect of dropping his pieces of metal from a spoon or tongs of another metal, and made a large number of experiments upon the effect of heating or cooling the pieces of metal before they were dropped upon the tin plate. At the end of his experiments, he said, among his other conclusions:

> I am inclined to suspect that different bodies have different capacities for holding the electric fluid, as they have for holding the elementary heat.

In the meantime, Volta had discovered the existence of an electric current in a circuit made of two metals and a moist conductor. He first thought the source of the current to be in the surfaces of contact of the metals with the moist conductor, but later concluded that the current was not only originated, but was sustained, by the mutual contact of two metals of a different kind. In support of this conclusion, he published a series of experiments on contact electrification which were a virtual repetition of Bennett's experiments which had been published eight years before, but for which Volta gave Bennett no credit.

Meanwhile, in 1792, Fabroni had published his celebrated paper entitled "Upon the Chemical Working of the Different Metals upon Each Other at Ordinary Air Temperatures, and Upon the Explanation of Certain Galvanic Phenomena." In this paper Fabroni showed that the surface cohesion of different metals is changed merely by their mutual contact, so that metals which before contact were not attacked by the oxygen of the air or of water are readily oxidized when in contact with another less oxidizable metal. When Volta's discovery of the current was announced, Fabroni naturally concluded that the chemical action which took place at the surface of contact of at least one of the metals and the moistened membrane was the cause of the electrical current.

As a result of the controversy which followed regarding the source of the electromotive force in the voltaic current, a similar controversy arose over an entirely different question, viz., as to whether the transference of electricity from one metal to another as observed by Bennett and Cavallo was a primary phenomenon of metallic contact, or whether it was due to a preceding action of oxygen or some other element upon one or both of the metals. Ostwald, speaking of the theory of direct electrification by contact says:

[1] Read before a joint meeting of Section B of the American Association for the Advancement of Science and the American Physical Society, at Berkeley, California, August 5, 1915.

We stand at a point where the most prolific error of electrochemistry begins, the combating of which has from that time on occupied almost the greater part of the scientific work in this field.

This opinion has undoubtedly been shared by most chemists and by many physicists from that day to this.

It seems strange that those champions of the theory of the chemical origin of the contact charge who look upon Fabroni as the founder of their theory have overlooked the fact that what Fabroni especially undertook to show in his paper was that the mere contact of two metals weakens the cohesion between the molecules of at least one of them, and that this change was precedent to the chemical action which he regarded as the cause of the electrical current. Since we now know that cohesion is an attraction between the electropositive and electronegative ions of the metal, or more definitely, between the positive sub-atoms and the electrons within the metal, if we accept the foundation hypothesis of Fabroni we must conclude that the mere contact of two different metals produces a change in the electrical forces between their surface atoms before any chemical action is set up.

That this opinion was shared by Berthollet may be gathered from a translation in *Nicholson's Journal*[2] of a part of Berthollet's "Essai de Statique Chimique."

After a discussion of a number of experiments performed by Charles and Gay Lussac for the purpose of deciding whether the dissipation of a fine wire by the electric discharge of a Leyden jar was due to the heating effect of the spark or to some other cause, and their conclusion that the wire was not vaporized by heat, Berthollet concludes that the dispersion of the metallic particles precedes their oxidation, and says:

Electricity favors this oxidation, inasmuch as it diminishes the force of cohesion; it is thus that an alkali renders the action of sulphur on oxygen much more powerful, by destroying the force of cohesion opposed to it, and that a metal dissolved in an amalgam is oxidized more easily than when it is in the solid state.

All the chemical effects produced in substances submitted to the action of electricity seem capable of being deduced from these considerations, and of being explained by the diminution of the force of cohesion, which is the obstacle to the combinations which their molecules tend to form.

[2] Vol. 8, p. 80.

The fundamental question at issue in the century-long battle which has been fought over contact electrification has been: Are the charges which are found upon two plates of different metals when they have been placed in contact and then separated due to some chemical action which has taken place at the time of contact, or were the two metals before they were brought into contact already electrically different with respect to each other? Or, since metals are said to be unelectrified when they have been put into good metallic contact with the earth while at a distance from other bodies, may two metals which are unelectrified with reference to the earth still be in different electrical states relative to each other?

Many physicists have maintained that two metals which have been discharged to the earth or to the inside of a hollow conductor are in absolutely the same electrical state, *i. e.*, that they are in a condition of absolute electrical neutrality. Others have believed that the change in the electrical state of both metals when they are brought into contact with each other proves that they were not in an electrically neutral condition before contact.

Among those who believe that before contact the metals are in an electrically neutral condition it is commonly held that the electrical displacement which occurs when two metals are brought into contact is due to the greater affinity of oxygen for one of the metals than for the other. Those who hold this view seem to overlook the fact that affinity for oxygen must be, itself, an electrical attraction. If zinc has an affinity for oxygen, it is because the zinc is either electropositive or electronegative to oxygen. If zinc has a greater affinity for oxygen than copper has, the zinc must be more electropositive or electronegative to oxygen than is copper, and in consequence it must be electropositive or electro-

negative to copper. This being the case, and both being conductors, they should when brought near together each induce a free charge upon the other.

This phenomenon was actually observed by Exner, who describes an experiment for showing it in *Repertorium der Physik,* XVII., 444 (1881). In this experiment a zinc plate was placed in a horizontal position, and after being discharged to earth was insulated. A similar copper plate could be lowered parallel to the zinc plate and very near it. This copper plate was earthed, then insulated and brought very near to the zinc plate and connected to an electrometer. This caused an electrometer deflection of + 9 scale divisions, due to the free charge induced upon the copper plate by the zinc. The copper plate and electrometer while still connected were earthed, and the electrometer deflection returned to zero. They were then again insulated, and while still connected, the copper plate was raised from the zinc plate. The electrometer then showed a deflection of — 9 scale divisions, due to the bound charge which had been induced upon the copper plate. After the copper plate was removed the zinc plate was tested and showed no free charge, it having been insulated throughout the experiment.

This seems to show conclusively that a zinc plate which has been discharged to earth and insulated is capable of inducing a free positive charge upon an insulated copper plate which is brought near it.

Exner also showed that when a platinum plate and a zinc plate, after having been discharged to earth and then insulated, are brought very near together each induces a free charge upon the other which may be shared with an electrometer. If the electrometer be connected first with the platinum plate it will show a positive charge. If the electrometer and plate be discharged to earth and again insulated and the electrometer connected to the zinc plate, it will show a negative charge. After this has been discharged to earth and the plate and electrometer again insulated the platinum will show another positive charge. In this way Exner was able to take twenty successive charges, alternately positive and negative, from his plates before their induced free charges were entirely discharged. This corresponds exactly to discharging the conductors of an insulated Leyden jar alternately.

The free charges induced by the approach of different metals to each other are discussed by Majorana in *Phil. Mag.,* XLVIII., p. 241, where they are called approach charges. Majorana also showed the attraction of one metal upon another at very small distances.

It is difficult to see how these induced charges can be accounted for by any chemical explanation. Neither can they be accounted for on the assumption of a double electric layer of any kind on the surface of the metal, since the distance between the positive and negative surfaces in such a layer would necessarily be so small that their differential effect would vanish at very small distances, and the induced charges may easily be observed when two plates of different metal are more than a centimeter apart. They may even be shown at much greater distances by using a hollow conductor of one metal and introducing the other metal into it. In this way an induced charge may be taken from the outer surface of the hollow conductor without bringing the two metal surfaces near together. In this case all talk of a double electrical layer is excluded, as is also any chemical action taking place within the hollow conductor after the inner metal is introduced.

This induced charge upon the outer hollow conductor may be shown even while the inner metal is in contact with the earth or with the inside of an earthed hollow conductor. A simple method of doing this is as follows:

A Dolazalek quadrant electrometer, *E,* in the diagram, is enclosed in a cage of fine wire mesh which is earthed through a wire soldered to the water system of the laboratory. The outer case of the electrometer and one pair of quadrants are connected to this cage. The other pair of quadrants is connected to a hollow metal cylinder, which may conveniently be about 15 centimeters long and 2 cm. in internal diameter. This cylinder, *C,* in the diagram, is supported horizontally upon hard rubber blocks inside the cage.

A round metal rod or tube, *R*, in the diagram, about one centimeter in diameter, is mounted in earthed metal guides which are concentric with the hollow cylinder, *C*. One of these guides passes through the wall of the wire cage, and is in metallic contact with it. A hole is cut in the cage opposite the other end of the hollow cylinder, so that the rod can be pushed concentrically through the hollow cylinder without touching its walls. The rod is thus always in contact with the cage which forms the earthed hollow conductor, and the part of it within the hollow cylinder is also within this earthed hollow conductor and in metallic contact with its walls.

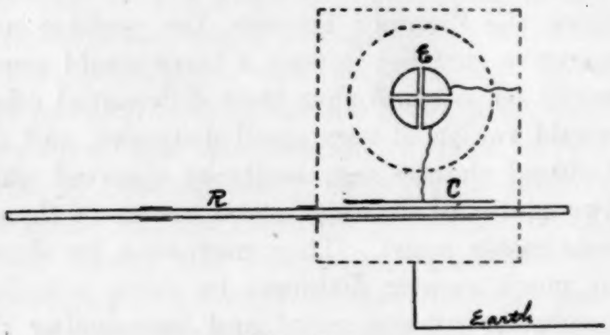

Fig. 1.

Before beginning an experiment, the needle of the electrometer, which was suspended by a quartz fiber, was charged from 200 dry cells and then insulated. The hollow cylinder, *C*, was then put in contact with the outer cage so that the free charge induced upon it by the electrometer needle might be taken off. When, now, the earthed rod was pushed through the cylinder, a charge was induced upon the cylinder which varied with the metal of the rod. Thus when a compound rod consisting of rods of the same diameter of zinc and copper put together, end to end, was pushed through the cylinder, the electrometer needle was differently deflected according as the zinc or copper part of the rod was in the cylinder. Thus in one experiment the copper part of the rod was pushed through the cylinder *C*, which was then discharged to the cage and again insulated. The zinc part of the rod was then pushed into *C*, and the electrometer showed a deflection of 12.5 scale divisions. This was repeated regularly many times. When the whole rod was withdrawn from the cylinder and an insulated copper rod of the same diameter was substituted for it and was alternately connected to the zinc and the carbon of a single dry cell, the electrometer gave a difference of scale reading of 35 scale divisions. Since the electromotive force of the dry cell used was about 1.25 volt, the difference of deflection for the zinc and copper ends of the rod indicated a difference of electric state of about .4 volt, the zinc being electropositive to the copper. This difference remained unchanged when the rod was in contact with the outer cage on both sides of the cylinder *C*.

By substituting an induction cylinder only 2.5 cm. long for *C*, it was found that the zinc was most electropositive next to the copper, and that its electropositive charge decreased gradually with the distance from this junction.

It has been known since the experiments of Cavallo that the contact charges of two metals depend upon their temperature. Since the contact charges which have been observed from Bennett's time on are apparently the bound charges induced by the two metals upon each other when close together, it was to be expected that the charges which metals hold while in contact with the earth or with the inside of a hollow conductor should vary with the temperature of the metal. By heating one section of a rod of a single metal and cooling another section, this expectation was verified. Thus, in the case of iron, steel, copper, brass and tin, the warmer part of the rod was electronegative to the colder part; in aluminium the warmer part became markedly electropositive, while in zinc the change was very slight.

Since the Thomson effect in iron indicates a change in the direction of the electromotive force at the junction of a hot and a cold part at about 150 degrees, an attempt was made to heat one end of a steel tube and keep the other end cold and measure the change of induced charge with a change in temperature. It was found that the tube used became more electronegative as its temperature increased up to 150 degrees, or more. From 150 to 200 de-

grees the electric charge of the metal changed very little, but beyond 200 degrees the tube became more electropositive with an increase in temperature. It was impossible to measure the induction of the tube much beyond 200 degrees, since at higher temperatures the hot tube ionized the air and allowed the induced charge of the cylinder to discharge to the tube.

It is interesting in this connection to note that the internal cohesion of iron and steel seems to change with a change in the fixed electric charge of the metal. In a paper on "Contact Electromotive Force and Cohesion" written several years ago it was shown that when the metals are arranged in their proper order in the contact electromotive series they are arranged in the inverse order of their cohesion, so that the more electronegative a metal is in the contact series the greater is its cohesion. Since in the case of the steel tube used in the experiment described above the metal became more electronegative up to a temperature of about 150 degrees, it would seem to be a legitimate deduction that the tensile strength of the tube should increase up to this temperature and then begin to decrease with a rise of temperature.

In a series of experiments made by C. Bach and described in *Zeitsch. d. Deutsch. Ingénieure*, 1904, p. 1300, the tensile strength of iron was actually found to be much greater at 200 degrees than at 20 degrees. From 200 to 300 degrees it decreases, but it is still greater at 300 degrees than at 20 degrees. At 400 degrees it is only a little less than at 20 degrees.

In the *Valve World* of January, 1913, is an article by I. M. Bregowski and L. W. Spring on "The Effect of High Temperatures on the Physical Properties of Some Metals and Alloys." In this article it is shown that samples of cast iron, both soft and hard, have a greater tensile strength at 300° F. than at 70° F., and that at 750° F. the tensile strength is still within one per cent. of as great as it is at 70° F. In the case of a sample of Crane Ferrosteel the tensile strength is greater at 750° F. than at 70° F.

In a dissertation by A. Lantz, entitled "Einwirkung der Temperatur auf die Biegfähigkeit von Flusseisen und Kupferdraehten," Berlin, 1914, the author finds that what he calls the *Biegfähigkeit* of iron, *i. e.*, its malleability or toughness as measured by the number of times it can be bent short forward and backward at a given point before breaking, increases with the temperature to about 220 degrees and then decreases. In some cases the wire would stand twice as many short bendings at 220 degrees as at room temperature, while at 350 degrees it would stand only one fifth as many as at room temperature. The toughness of copper measured in this way continued to increase to 320 degrees, which was the highest temperature of the experiment.

The above mentioned experiments all seem to indicate that the cohesion of iron increases with its increase of temperature so long as the iron continues to become more electronegative, and that the cohesion begins to decrease at about the temperature at which the iron begins to lose its negative charge.

This is what we should expect if cohesion is an attraction between positive and negative charges. An increase of cohesion would then mean a greater attraction of the positive subatoms of the metal for movable electrons and a consequent increase of the negative charge of the metal. So far as we know, such a change in the attraction of the positive sub-atoms for electrons can be brought about only by a change in the specific inductive capacity of the metal.

It would seem that all known phenomena of contact electrification may best be explained on the hypothesis that different metals when in electrical contact with the earth or with the inside of a hollow conductor, although by definition at zero potential, still actually retain characteristic charges which are capable of inducing a charge upon a different metal when brought near it. It is these characteristic charges which I have ventured to call the natural charges of the metals.

When two metals are brought near together while in electrical contact with the earth, their natural charges are increased or diminished by the bound charges due to their mu-

tual induction. If insulated while in this position and then separated, the whole or a portion of their bound charges become free charges. If while separated they are electrically connected with the earth, such a transference of electricity will take place between each of them and the earth as will restore their original fixed charges.

Since a metal within a hollow conductor of another metal is wholly within the field of induction of the outer metal, the fixed charge which the inner metal will take when in contact with the outer will be determined to the greatest possible extent by the bound charge induced by the outer metal. Accordingly, this will, in general, be different from the fixed charge which the inner metal will take in the earth's field alone. It follows from this that when two metals inside a hollow conductor are brought into contact with each other and with the outer hollow conductor, the bound charges which they acquire are partly due to their mutual induction and partly to the induction of the outer hollow conductor. If they are flat plates and are placed parallel and very close together when touched to the outer conductor, their bound charges may be quite largely due to their mutual induction; if they are spheres with their surfaces touching while they are put into contact with the outer conductor, their bound charges will be determined principally by the induction of the outer conductor.

Thus, a zinc ball about 5 centimeters in diameter was insulated by a silk thread and was lowered into a metal beaker of 750 c.c. capacity until it touched the bottom. It then held the fixed charge due to the induction of the surrounding beaker. When it was lifted out of the beaker, this charge became free, and could be shared with an electrometer. The tilted gold leaf electrometer of C. T. R. Wilson was used on account of its small capacity.

The difference in the gold leaf deflection due to twenty successive charges from the inside of the bottom of a copper beaker and to the same number of charges from the inside bottom of an exactly similar aluminium beaker was 20.8 scale divisions, when the sensitivity of the instrument was 14 scale divisions for an ordinary dry cell.

A disc of tinfoil a little larger than the bottom of the beaker was then pressed down into each beaker until it rested on the bottom and was turned up about a centimeter around the inside of the beaker. The zinc ball was then charged as before by contact with the tinfoil instead of the metal of the beaker. As a mean of twenty such readings for each beaker made exactly as before the electrometer deflection amounted to 20 scale divisions for the difference of charge taken from the tin foil inside the two beakers. This showed that the fixed charges induced upon the zinc ball were due almost wholly to the outside beakers instead of the inside tinfoil.

The beakers were then inverted and the tinfoil discs were placed on the outside of their bottoms and the zinc ball charged by contact with the tinfoil as before. Here, where inductive influence of the beakers was almost wholly removed, the difference of the charges taken from the tinfoil discs averaged only 1.2 scale divisions, which was not greater than the probable error of the experiment.

A third series of readings was then made with the beakers loosely wrapped on the outside with tinfoil which was turned in for a centimeter or so around the top. The zinc ball was lowered into the beakers and charged by contact with the bottom, as in the first series of experiments, both with the tinfoil around the beakers and with it removed. In this series, the difference in deflection due to the two beakers without the tinfoil was 23.4 scale divisions, while with the beakers wrapped in tinfoil it was only 7.5 scale divisions. In this case, since the bound charges induced by the tinfoil wrapping upon the two beakers were different from their normal fixed charges, the charges which they, in turn, induced upon the zinc ball were also different from the charges which they induced with the tinfoil wrapping removed.

Summary

I have tried to show in the preceding paper that metals, and probably all other bodies,

when in electrical contact with the earth still retain characteristic charges which are capable of inducing electric separations in other bodies brought near them.

That when two metals are brought near together, their induced free charges will escape to the earth or to any other conductor with which they may be in metallic contact.

Their bound charges remain in or on the metal. If after their free charges have escaped the metals be insulated and then separated, the bound charges become free, and are the so-called contact charges of Bennett and Cavallo.

The magnitude of the natural charge of a metal seems to be determined by its internal cohesion, and hence presumably by its specific inductive capacity. Whatever changes the specific inductive capacity of the metal, or even of its surface, will accordingly produce a change in the fixed charge of the metal.

This point of view consists merely in introducing the earth into the contact series. It seems certain that the same metal will hold different charges when in contact with different parts of the earth, as it will when in contact with the interiors of different hollow conductors.

Fernando Sanford

Stanford University

THE FIRE AND THE MUSEUM AT OTTAWA

The Museum of the Geological Survey, Ottawa, Canada, is to Canada practically what the National Museum is to the United States and the British Museum to the United Kingdom. This museum has been greatly affected by the fire which, beginning about 9 P.M., Thursday, February 3, 1916, destroyed the Dominion Parliament building and caused the loss of several lives. Before 2 A.M., February 4, while the flames were still spreading, a member of the cabinet was considering the use of the large auditorium in the Victoria Memorial Museum building as possibly a suitable place for the meetings of the House of Commons, and members of the Geological Survey were holding themselves in readiness to clear any of the other space necessary. It will be remembered that this museum building was the home of the Geological Survey of Canada and the temporary quarters of the National Gallery of Canada. It was open to the public from nine till five daily except Sundays, Christmas day and Good Friday, and from two till five on Sundays during the winter.

On the ground floor were the central hall, usually with special and timely exhibits, the main floor of the auditorium, the west hall with tentative mineralogical exhibits, the west wing for geology, but containing boxed specimens and camp equipment, the east hall with invertebrate paleontological exhibits, and the east wing with tentative exhibits of vertebrate paleontology.

On the first floor were the tower hall with some ethnological specimens, the lecture hall gallery, the west hall—three fourths devoted to tentative archeological exhibits and one fourth occupied by entomological exhibits—the west wing with permanent archeological and ethnological exhibits, and the east hall with zoological exhibits. On this same floor the east wing was occupied by Canadian pictures, and Greek, Roman and Italian renaissance sculpture, of the National Gallery. On the second floor were most of the offices and the library of the Geological Survey, and in the northeastern room of the east hall an office of the National Gallery. On the same floor the east wing was occupied by Medieval and French renaissance sculpture, Royal Canadian Academy Diploma Pictures and colored prints of the world's most famous pictures, of the National Gallery. On the third or top floor were offices, the much used though small and tentative museum lecture hall, the gallery of the library, the drafting room, study and storage rooms. On this floor the east wing was occupied by the oil and water colors, prints, etchings, drawings and bronzes of the National Gallery. In the basement were work shops, laboratories, distribution offices, photographic department, and half a hall devoted to a workshop of the National Gallery.

The Geological Survey, it may be seen, oc-

cupied practically all the building except the three and a half floors in the east wing and an office which were used by the National Gallery. Each hall and wing is practically one hundred and twenty feet long by sixty feet wide. The central hall was temporarily vacant and here the post office for the House of Commons, telephones, and two telegraph offices were installed before noon, or within less than fifteen hours after the fire started.

About ten A.M., February 4, the morning of the fire, the survey staff was informed of the intended use of the building as a temporary home for the Dominion Parliament. The large auditorium with its gallery, which was only partially furnished and had been but little used for lectures, was immediately released from museum uses and prepared by the Department of Public Works, so that the House of Commons was enabled to begin its session at 3 P.M. or in less than twenty hours after its deliberations had been disturbed by the fire. The throne, used by the Governor-General in the privy-council room, which was rescued from the fire, served for the speaker of the House of Commons. A press gallery was built back of the speaker.

The west hall was occupied by the tentative exhibit of minerals. This exhibit was packed and removed in six hours or by 4 P.M., Friday, which was less than twenty hours after the fire began. The costly cases in which these minerals were exhibited had meanwhile been taken apart and placed in storage. Rooms for the members of the Senate were made here.

The west wing, which was being prepared for geological and mineralogical exhibits, was cleared before Monday noon. The southern half of this hall was decorated, carpeted with the traditional scarlet carpet, and furnished with furniture, most of which had been saved from the Senate chamber. The walls were hung with portraits also rescued from the chamber, placed in order, King George III. and Queen Charlotte leading the others, which consist of the portraits of the speakers of the Senate, ranged in the order of precedence. The Senate met at 8 P.M. on Tuesday in this new chamber within seventy-five hours after it became known that the Senate would meet in the museum. North of the aisle the Senate Post Office and other rooms for their convenience have been built.

The east hall with invertebrate paleontological exhibits, similar in size to the other exhibition halls, contained thousands of small and delicate specimens. These were all carefully wrapped, packed and taken away. The work of dismantling had progressed so far by midnight or within twenty-eight hours after the origin of the fire, that the Public Works carpenters were enabled to begin erecting the walls of the offices for the convenience of the members, and twelve hours later or forty hours after the beginning of the fire all the museum specimens and cases had been moved from this part of the building, which was made into offices for members of the House of Commons.

Of the east wing containing tentative vertebrate paleontological exhibits, three quarters were cleared and these exhibits were stored, with those of the other quarter, along the walls of the southern half of the hall. This clearing involved not only the moving of small exhibits in cases, but also of such heavy fragile specimens as the titanotherium and the skulls of dinosaurs and mammoths, yet it was all done within two hours after this notification, that is by noon, or in less than twenty hours from the time that the fire broke out.

The ethnological specimens were taken out of the tower hall, which was then fitted up and used before Friday noon as a newspaper library corresponding to the one where the fire originated.

Before noon, that is within less than two hours after notice, the tentative exhibit of Canadian archeology in seventeen cases, covering three quarters of the west hall, was cleared of specimens and cases, while the tables upon which the cases stood were left for the use of the members of parliament. The specimens were transferred to sixty-eight trays and stored in the archeological laboratory in the basement. Meanwhile the remaining quarter of the hall had been cleared of a tentative exhibit of entomology in four cases. In this hall a place for the press gallery staff

to work, various offices for members of the senate, and offices for the Hansard staff which records the deliberations of the house were made ready before Monday noon.

The exhibits in the permanent anthropological hall were left intact. Besides the exhibits the archeological specimens in storage under the exhibition cases were also undisturbed. The ethnological exhibits which are of specimens from the Eskimo, the Indians of the northwest coast of America and the Algonquian and Iroquoian Indians of the eastern woodlands, were undisturbed. The aisles in this hall, however, were used for storing furnishings and specimens from various other departments and for office space for the ethnologists.

The zoological hall, similar in size to the others, was cleared by Sunday noon. This necessitated the taking apart of splendid large group cases and the dismantling of groups of seals, mountain goat, mountain sheep, musk oxen and various other exhibits and the removal to storage in the aisles of the anthropological hall of the smaller cases containing exhibits of mammals, birds and reptiles. The space was divided up into offices for the members of the House of Commons.

The offices on the second floor were promptly vacated with the exception of two, that of the curator and mineralogist and that of the vertebrate paleontologist. The invertebrate paleontological offices were moved to the third floor. The archeological office was moved to smaller space in the entomological laboratory on the third floor, all specimens being taken to the laboratory. The known loss to archeological specimens caused by the move from both office and tentative exhibition is negligible, the damage being less than one dollar. Work on monographs will be hampered for lack of space to spread out the material for study, but every specimen is still available, on permanent exhibition, in storage under the exhibits, or in the laboratory where aisles allowing for the free passage of trays are maintained, though the storage reaches the ceiling in most of the remaining space. The ethnological office was moved into the south end of the anthropological exhibition hall and the botanical office was moved into the botanical herbarium on the third floor. The library was not disturbed. The vacated rooms were at once occupied chiefly by the Cabinet and other members of the House of Commons.

The offices, drafting room, workshops and storage on the third floor, were mostly retained, but the little lecture hall was released. The lectures in course were postponed indefinitely. The zoological study material and the herbarium were undisturbed. The physical anthropological office was concentrated into about half its former space, and an ethnological storage room was vacated.

In the basement the workshops and laboratories were mostly retained, as were the taxidermist department, the laboratory of vertebrate paleontology, the photographic department, and half a hall devoted to the workshop of the National Gallery. Some work rooms were vacated, however, and the distribution offices with their vast store of publications and maps were moved to another part of the city.

Of about a hundred and forty members of the survey staff over seventy moved about a mile to a series of buildings recently taken over by the government on the north side of Wellington Street between Bank and Kent Streets, while some sixty of those most intimately connected with museum work retained room in the Victoria Memorial Museum building. In this work of moving, militia motor lories were pressed into service, as well as sleighs and other transports, and the office furnishings and working specimens went out at the rate of sixty loads in one day.

The National Gallery of Canada turned over all its premises except two rooms, one on the first floor and one on the second, in which the art objects were compactly stored. It retained its offices and workshop. Thus it turned over about five sevenths of its space. The director of the gallery was called upon and he directed the hanging of pictures in the part of the building occupied by parliament and with his staff assisted in rescuing pictures from the parliament building. These activities afford an example of museum usefulness.

The Survey staff made space faster than it was required, always managing to keep ahead of the Public Works men. Under the direction of Hon. Robert Rogers, minister of public works, Mr. J. B. Hunter, deputy minister, Mr. John Shearer, superintendent of buildings, and their various assistants, the Public Works staff prepared the building for parliament by building walls, decorating, carpeting, installing telephones, two telegraph offices, two post offices and many other necessities and conveniences. They also provided facilities for those of the Survey staff remaining at the museum to carry on its work.

His Royal Highness, the Governor-General, inspected the House of Commons and the other parts of the Victoria Memorial Museum building turned over for the use of parliament at eleven A.M. on Monday, less than eighty-seven hours after the fire began or less than seventy-four hours after the museum authorities were notified of need for the space. He was apparently much pleased at the speed with which the survey staff had made room and with the facilities and comforts so hastily installed by the Public Works staff.

The museum retains intact only one and a quarter of the exhibition halls, namely, the anthropological hall and part of the hall of vertebrate paleontology. It is closed to the public, admission being by pass only.

A sample museum, by means of which to advance museum interests in the Dominion, has been begun in the anthropological hall. The archeological and ethnological exhibits are intact, some of the best zoological exhibition cases of birds, reptiles and insects, have been placed in the wider aisles where they may be viewed, while mounted mammals and skeletons of various animals have also been placed in the aisles and on top of the cases. In the unoccupied space of this character, and in such other space as may be made by storing all but a representative archeological series, still other exhibits may be placed.

On the whole the scientific work of the museum may go on practically unhampered. The lecture work is being carried on in other auditoriums. The exhibitions eventually may be facilitated by the present apparent set back, as the museum staff is undiscouraged, and the members of parliament, who are now in daily proximity to the exhibits and constantly meeting museum workers, may become so interested that they will provide future facilities for museum work in the Victoria Memorial Museum building or in a building even better adapted for museum purposes. Besides this they may carry home to all parts of the Dominion inspiration to establish useful museums and to improve those already in existence.

Harlan I. Smith
Museum of the Geological Survey,
Ottawa, Canada

ROBERT JAMES DAVIDSON

Robert James Davidson closed his earthly career suddenly December 19, 1915, leaving a beautiful and beneficent memory. Born at Armagh, Ireland, April 3, 1862, he attended schools near Liverpool, England, and came to this country as a youth. He was educated at South Carolina College and University, from which he received the degrees of Bachelor of Science and Master of Arts and in whose faculty he served for some six years. This preparation was to bear ripe fruit in the career which really commenced in 1891, when he was called to the chair of chemistry in the Virginia Polytechnic Institute at Blacksburg, Virginia. For nearly a quarter of a century he labored there teaching chemistry, administering the discipline of the college as professor and as dean, leading the farmers of the state with admonition and advice, and always ready to serve. One invariably thinks of the word *service* in remembering Davidson. It gives the keynote to the song of his life. Whether with his students, his colleagues, or his fellow-citizens, in fact with his neighbor wherever he met him, Davidson's first and main thought was to be of service and truly did he follow, far more closely than the average man, the example set by the Master nineteen hundred years ago. He was fearless in this service, never hesitating to state his objection to argument or his adverse opinion with the reasons

therefor, and this when he thought need be, whether or not it gave annoyance or even pain. But with this fearlessness to serve in the truest sense, was combined a gentleness that made his personality a strongly marked one in whatsoever society he chanced to be. For many years a sufferer from bodily pain, he went uncomplainingly, fearlessly but gently, keeping a lookout for opportunities to serve. A charming host to the stranger on the campus and to his colleagues, he was a big brother to every student who claimed his aid or would let himself be helped, and many a man has left the college the better for the glimpse of tender family love and gentleness which pervaded his hospitable home.

It was among his scientific colleagues, perhaps, that Davidson's personality stood forth most clearly defined. His attainments won recognition and he held a high place among the notable men of several important scientific organizations. He was a fellow of the American Association for the Advancement of Science, a member of the American Chemical Society, the Association of Official Agricultural Chemists, and the Washington Academy of Sciences. He was frequently chosen a delegate to important gatherings, as for instance, the International Congress of Applied Chemistry at London, and in 1903 he served as president of the Association of Official Agricultural Chemists. Never afraid to raise his voice for the truth as he saw it, always gentle and considerate of adversary or controversialist, ever anxious to compose differences of opinion and especially of feeling between opponents, and a faithful attendant at meetings, Davidson's membership in numerous and important committees was logical and inevitable. And these committees he served with his whole heart and his whole strength. It had a profound effect on his scientific life. With a strong mentality, wide and deep reading, a cheerful readiness amounting to eagerness to hear or learn of the work of others, and a patient and diligent effort to assimilate new ideas, he should have been a notable man in chemical research. While his contributions in this field, especially in the application of chemical ideas to the problems of soil management and farm practises are worthy of high praise, it was not humanly possible for any one to give to his college duties, to his work among farmers, and to his committee duties, the time and energy that Davidson gave, and at the same time gain unusual distinction in a specialized field of science. But fame was truly appraised by Robert James Davidson as of lesser importance than duty and the opportunity to serve. Though his name may not be remembered as linked with some particularly important milestone in the history of science, yet it will be remembered long, tenderly, and reverently, not only as a faithful worker in science, but as the man and the brother and a model in all the activities of a good citizen for his colleagues and his neighbors. Agricultural science has lost one of her most notable American pioneers and her most faithful servants.

FRANK K. CAMERON

THE ROCKEFELLER FOUNDATION AND THE GENERAL EDUCATION BOARD

ANNOUNCEMENT is made of the annual election of officers of the Rockefeller Foundation. President John D. Rockefeller, Jr., and Secretary Jerome G. Greene were reelected. The executive committee is now John D. Rockefeller, Jr., Simon Flexner, Starr J. Murphy, Wickliffe Rose and Jerome D. Greene. The finance committee is John D. Rockefeller, Jr., A. Barton Hepburn and Starr J. Murphy. The Foundation has elected as new trustees, Martin Antoine Ryerson, of Chicago; the Rev. Dr. Harry Emerson Fosdick, of Montclair, N. J., and Frederick Strauss, of New York. Mr. Ryerson is president of the board of trustees of the University of Chicago. The Rev. Dr. Fosdick is pastor of the First Baptist Church, Montclair, and the Morris K. Jesup professor of practical theology in the Union Theological Seminary.

From the trustees of the estate of Mrs. John D. Rockefeller, Sr., the foundation has received a gift of $49,860, which is in addition to a previous gift from Mrs. Rockefeller's estate of

$340,874. The capital fund of the Foundation on January 1, 1915, was $100,048,000.

Appropriations amounting to $1,200,000, not hitherto announced, have recently been made by the Foundation. To the Rockefeller Institute for Medical Research is given $1,000,000 for additional endowment needed in connection with the Department of Animal Pathology, recently established near Princeton, N. J. To the Rockefeller Institute for Medical Research, $25,000 goes for the cost of medical research and such medical supplies and services as the institute may appropriately furnish at the seat of war in Europe. Most of this appropriation will be used for the support of the research and hospital work being conducted by Dr. Alexis Carrel in France. The China Medical Board receives $125,000 for the purchase of additional property adjoining the Union Medical College in Pekin for the promotion of medical teaching in China. The international committee of the Young Men's Christian Association receives $50,000 in support of the work in the military prison camps of Europe.

The General Education Board, founded by John D. Rockefeller "to promote education within the United States" without distinction of race, sex or creed, will shortly issue its complete annual report for the fiscal year 1914–15. The first installment of that report, made public this week, shows that since its organization and up to June 30, 1915, the board had appropriated directly $16,862,147.71. Of this amount, $10,848,084.07 had been paid out, and $6,014,063.64 was awaiting requisition.

Up to that date the board had appropriated its entire accumulated income with the exception of $198,992.35.

The report shows the value of the board's resources, supplied by Mr. John D. Rockefeller, to be $33,958,848.40, of which $30,918,063.80 is general endowment and $3,040,784.60 reserve fund.

The gross income from these funds for 1915 was $2,230,425.41. In addition, the Anna T. Jeanes Fund, which is administered by the board, yielded an income of $7,910.46. The administration of these funds is in the hands of a board of trustees consisting of Frederick T. Gates, chairman; Walter H. Page, John D. Rockefeller, Jr., Albert Shaw, Wallace Buttrick, Starr J. Murphy, Edwin A. Alderman, Hollis B. Frissell, Harry Pratt Judson, Charles W. Eliot, Andrew Carnegie, Edgar L. Marston, Wickliffe Rose, Jerome D. Greene, Anson Phelps Stokes, Abraham Flexner and George E. Vincent.

The General Education Board's appropriations up to June 30, 1915, had been as follows:

Universities and colleges for whites for endowment	$11,672,460.16
Medical schools	2,670,874.11
Colleges and schools for whites, for current expenses	159,991.02
Colleges and schools for negroes	811,781.13
Southern Education Board	97,126.23
Salaries and expenses professors of secondary education	275,580.01
Salaries and expenses supervisors negro rural schools	84,320.57
Salaries and expenses rural school agents	70,645.77
Farmers' cooperative demonstration work in south	716,077.80
Farmers' cooperative demonstration work in Maine	45,173.67
Farmers' cooperative demonstration work in New Hampshire	24,593.49
Girls' canning and poultry clubs in south	113,751.52
Girls' and boys' clubs in Maine	11,205.12
Rural organization work	36,646.83
Conferences	18,420.28
Educational surveys	32,500.00
Home Makers' Club agents in southern states (colored)	15,000.00
Rural education	6,000.00
	$16,862,147.71

CENTENNIAL OF THE COAST AND GEODETIC SURVEY

EXERCISES in celebration of the hundredth anniversary of the establishment of the United States Coast and Geodetic Survey will be held on Wednesday, April 5 and Thursday, April 6. The program is as follows:

Afternoon of April 5, at the New National Auditorium, Washington, D. C. Beginning at 2:30 p.m.

Dr. Hugh M. Smith, Commissioner of the United States Bureau of Fisheries: "The Bureau of Fisheries and its Relation to the United States Coast and Geodetic Survey."

Dr. Louis A. Bauer, Director of the Department of Terrestrial Magnetism, Carnegie Institution of Washington: "The Work Done by the United States Coast and Geodetic Survey in the Field of Terrestrial Magnetism."

Dr. S. W. Stratton, Director of the United States Bureau of Standards: "The Bureau of Standards, and its Relation to the United States Coast and Geodetic Survey."

Rear Admiral J. E. Pillsbury (Retired), United States Navy: "Ocean Currents and Deep Sea Explorations of the United States Coast and Geodetic Survey."

Dr. George Otis Smith, Director of the United States Geological Survey: "The United States Geological Survey and its Relation to the United States Coast and Geodetic Survey."

Evening of April 5, at the New National Auditorium, Washington, D. C. Beginning at 8:00 p.m.

Hon. J. Hampton Moore, Member of the United States House of Representatives: "The United States Coast and Geodetic Survey's Part in the Development of Commerce."

Brigadier General W. M. Black, Chief of Corps of Engineers, United States Army: "The United States Corps of Engineers and its Relation to the United States Coast and Geodetic Survey."

Hon. George R. Putnam, Commissioner of the United States Bureau of Lighthouses: "The Lighthouse Service and its Relation to the United States Coast and Geodetic Survey."

Mr. George Washington Littlehales, Hydrographic Engineer, United States Hydrographic Office: "Hydrography and Charts with Special Reference to the Work of the United States Coast and Geodetic Survey."

Afternoon of April 6, at the New National Auditorium, Washington, D. C. Beginning at 2:00 p.m.

Professor William Henry Burger, Professor of Civil Engineering, Northwestern University: "The Contribution of the United States Coast and Geodetic Survey to Geodesy."

Rear Admiral Richard Wainwright (Retired), United States Navy: "The Civil War Record of the United States Coast and Geodetic Survey, and What the Survey is Doing towards Preparedness."

Dr. Otto Hilgard Tittmann, President of the National Geographic Society: "The International Work of the United States Coast and Geodetic Survey."

Dr. Charles Lane Poor, Professor of Celestial Mechanics, Columbia University: "Oceanic Tides with Special Reference to the Work of the United States Coast and Geodetic Survey."

Dr. Douglas Wilson Johnson, Associate Professor of Geology, Columbia University: "The Contribution of the United States Coast and Geodetic Survey to Physical Geography."

Evening of April 6, Banquet at the New Willard, Washington, D. C. Beginning at 8:00 p.m.

Speakers: The President of the United States, The Minister of Switzerland, The Secretary of the Navy, The Secretary of Commerce, Dr. Thomas Corwin Mendenhall. The first superintendent, Professor Hassler, was a native of Switzerland. Doctor Mendenhall is the oldest living ex-superintendent.

Exhibit of the United States Coast and Geodetic Survey at the New National Museum, Washington, D. C. Wednesday, April 5, 1916. Open 10 a.m. to 11 p.m. and Thursday, April 6, 1916. Open 10 a.m. to 6 p.m.

This exhibit will consist of surveying instruments and appliances, pictures of surveying operations and equipment; charts and other publications of the bureau. As far as possible the earliest instruments and appliances which were used by this bureau will be exhibited beside those now in use. The earliest maps and charts of the United States which can be obtained will be shown for comparison with the present charts issued by the bureau.

The superintendents of the Coast and Geodetic Survey and the periods during which they served are as follows:

Ferdinand Rudolph Hassler	1816–1843
Alexander Dallas Bache	..1843–1867
Benjamin Osgood Peirce	..1867–1874
Carlile Pollock Patterson	..1874–1881
Julius Erasmus Hilgard	..1881–1885
Frank Manly Thorne	1885–1889
Thomas Corwin Mendenhall	1889–1894
William Ward Duffield	...1894–1897
Henry Smith Pritchett	1897–1900
Otto Hilgard Tittmann	...1900–1915
Ernest Lester Jones	1915–

SCIENTIFIC NOTES AND NEWS

Dr. Henry Fairfield Osborn, president of the American Museum of Natural History, will give the William Ellery Hale Lectures at the approaching meeting of the National Academy of Sciences. The subject is "The Origin and Evolution of Life on the Earth."

The following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the society: Professor E. H. Barton, Mr. W. R. Bousfield, Mr. S. G. Brown, Professor E. G. Coker, Professor G. G. Henderson, Mr. J. E. Littlewood, Professor A. McKenzie, Professor J. A. MacWilliam, Mr. J. H. Maiden, Professor H. H. W. Pearson, Professor J. A. Pollock, Sir L. Rogers, Dr. C. Shearer, Professor D'Arcy W. Thompson, Mr. H. Woods.

It is stated in *Nature* that Mr. Douglas W. Freshfield, president of the Royal Geographical Society, M. Henri Curdier, the French Orientalist, and General Schokalski, the Russian oceanographer, have been elected honorary members of the Italian Royal Geographical Society.

The Accademia dei Lincei of Rome has awarded the King's prize of £400 for human physiology to Dr. Filippo Bottazzi, professor of physiology in the University of Naples.

Dr. George Sarton, who is now lecturing in the United States on the history of science, the former editor of *Isis,* an international review devoted to the philosophy and history of science, published in Belgium, but discontinued during the war, has been awarded the Prix Binoux by the Paris Academy of Sciences.

Professor Metchnikoff has been seriously ill at the Institut Pasteur. Sir Ray Lankester writes to *Nature* under date of February 26 that his medical attendants believe that the pleurisy will now soon disappear and that the pulmonary congestion has already disappeared.

The city of Philadelphia, acting on the recommendation of the Franklin Institute, has awarded the John Scott Legacy medal and premium to Hans Hanson, of Hartford, Conn., for his inventions embodied in John Underwood and Company's combined typewriting and calculating machine, and has also awarded the John Scott Legacy medal and premium to Frederick A. Hart, of New York, N. Y., for his inventions embodied in the same machine. In consideration of the part performed by the staff of John Underwood and Company in the development of this machine, The Franklin Institute has awarded its Edward Longstreth medal of merit to John Underwood and Company, of New York, N. Y.

The prize of $1,000 offered through the American Social Hygiene Association by the Metropolitan Life Insurance Company for the best pamphlet on social hygiene for girls and boys has been awarded to Dr. and Mrs. Donald B. Armstrong, of Stapleton, N. Y. The paper will soon be issued by the company as one of the health and welfare series published for the benefit of its policyholders.

J. Warren Smith, head of the Columbus weather bureau for eighteen years and professor of meteorology at the Ohio State University, has been promoted to be chief of the division of agricultural meteorology with headquarters in Washington.

George W. Simons, Jr., assistant to the head of the Sanitary Engineering Department of Harvard Medical School and Massachusetts Institute of Technology, has been appointed chief sanitary engineer to the State Board of Health of Florida, and will take up his new work on July 1.

"Lassen Peak, our Most Active Volcano," is the title of a lecture recently given by J. S. Diller, of the United States Geological Survey, at Hunter College and before the Physi-

ographers' Club at Columbia University in New York, and the geological department of Lehigh University, South Bethlehem, Pa.

ON the occasion of the initiation ceremonies of the Yale Chapter of the Society of the Sigma Xi, on March 18, Professor J. McKeen Cattell, of Columbia University, gave the address, his subject being "Scientific Research as a Profession."

PROFESSOR S. A. MITCHELL, director of the Leander McCormick Observatory of the University of Virginia, delivered a lecture in Ottawa on March 22 before the Royal Astronomical Society of Canada on the subject "The Exact Distances of the Stars."

PROFESSOR FRANCIS G. BENEDICT, of the Nutrition Laboratory in Boston, lectured, March 14, at Wellesley College on "Living Without Food for Thirty-one Days. A Study in Prolonged Fasting."

MR. FRANK C. BAKER, zoological investigator of the New York State College of Forestry, at Syracuse, addressed, on February 25, the Syracuse Chapter of Sigma Xi on the "Relation of Molluscs to Fish in Oneida Lake."

PROFESSOR M. WEINBERG, of the Pasteur Institute, Paris, delivered a lecture on bacteriological and experimental researches on gas gangrene, with epidiascope demonstration, before the Royal Society of Medicine, London, on March 10.

PROFESSORS MARAGLIANO, of Genoa, and Rummo, of Naples, vice-presidents of the Italian Society of Internal Medicine, have issued an appeal for funds for the erection of a statue of the late Professor Baccelli to be placed in the Policlinico at Rome, in the foundation of which Baccelli took a leading part.

THE Elisha Mitchell Scientific Society held in the chemistry hall of the University of North Carolina on March 14, a memorial meeting in honor of Joseph Austin Holmes, late chief of the Bureau of Mines. The speakers were: Dr. F. P. Venable, Dr. J. H. Pratt and Dr. K. P. Battle.

ERASMUS DARWIN LEAVITT, of Cambridge, Mass., an engineer who made a specialty of pumping and mining machinery, past president of the American Society of Mechanical Engineers, died on March 11, aged eighty years.

ELTON FULMER, Washington state chemist and senior member and dean of the faculty of the Washington State College, Pullman, was killed in a railroad wreck at Cheney, Washington, on February 20, 1916.

MISS ADELE MARION FIELDE, known to scientific men for her work on ants, carried on at the Marine Biological Laboratory during a number of summers, died at Seattle on February 22, aged seventy-seven years. Miss Fielde was a missionary in Siam and China from 1866 to 1889, and is the author of several books concerned with Chinese conditions and Chinese folklore. She had been for many years active in movements for civic and social betterment.

THE death is announced, at Streatham, on February 18, of Professor R. H. Smith, formerly professor of engineering at the Imperial University, Tokio, and afterwards professor of civil, mechanical and electrical engineering at the Mason College, Birmingham.

DR. T. S. HALL, lecturer in biology in the University of Melbourne, and previously director of the School of Mines at Castlemaine, has died at the age of fifty-eight years.

DR. CHARLES GIRARD, professor of clinical surgery at the University of Geneva, Switzerland, has died in his sixty-seventh year.

DR. WALTER LOEB, head of the chemical department of the Rudolf Virchow Hospital in Berlin, died on February 7, aged forty-four years.

DR. WILHELM DEACHAES, curator of geology in the Hanover Museum, has been killed in the war.

ON April 1 the Illinois State Civil Service Commission will hold an examination for the position of geologic clerk in the office of the State Geological Survey. This position pays a starting salary of $75 a month with possi-

bility of later increase to $150. On May 6 an examination will be held for the position of assistant geologist. This position under the State Geological Survey pays a starting salary of $75 a month with possibility of increase to $120. The positions are open to persons over 21 years, including non-residents of Illinois. These examinations are unassembled. Questions relating to training and experience will be mailed to the applicants at their homes. The answers can be mailed to the commission, thus doing away with the necessity of non-residents coming to Illinois. If necessary, those who give satisfactory evidence of ability in this preliminary examination will be called together later for a personal interview at which final ratings will be assigned. For application blanks, address the Illinois State Civil Service Commission at Springfield, Illinois, or Room 904, 130 North Fifth Avenue, Chicago.

The New York State Civil Service Commission announces an examination on April 8 for zoologist in the State Museum, State Education Department, at a salary of $1,200. Candidates (men only) must have a general knowledge of biology, special training in zoology and a particular acquaintance with the animal life of New York state. They should also have a particular knowledge of the best methods of museum display, with ability to supervise work in taxidermy. Special credit will be given to those who have had actual experience in museum work and who have superior educational qualifications. There will at the same time be held an examination for examiner in the Educational Department, open to men and women. These examinations are held to provide eligible lists for permanent appointments at salaries of $900 to $1,500, and also to provide for a considerable number of temporary examiners required during the summer months at salaries from $75 to $125 a month. In all groups except commercial subjects and drawing, candidates must be graduates of a normal school or of an approved college and must have had three years' teaching experience in an approved secondary school in the subject or subjects in which they desire to be examined. No written examination will be given but candidates will be rated on education, training and experience as determined from the sworn statements in their application blanks and from responses to such inquiries as the commission may deem advisable to make. An oral examination may also be held. In filling out application blanks, candidates are requested in answer to question 20 to make full statement regarding experience. Applications will now be accepted for nine groups, including mathematics, physical science and biological science.

The agricultural department of the University of Minnesota is taking the lead in a movement to establish a national honorary society for agricultural students similar to Phi Beta Kappa and Sigma Xi. The plans for such a society have been formulated by a committee of faculty members of the college of agriculture, Professor A. V. Storm being chairman of the committee. Correspondence with other agricultural colleges is being conducted and it is hoped that such a society may be organized some time during the present college year. The standards of the new society will be high and membership will be based entirely upon scholarship in agriculture. The present plan is to take in senior students of the college of agriculture, graduate students in agriculture, and men who are doing practical work of unusual value in the field of practical agriculture. The movement started about a year ago with a group of agricultural students.

Corrosion of metallic structures is one of the most serious problems of modern engineering. It still awaits its solution. While it is a chemical phenomenon, electrical engineers are vitally interested in it, on account of the trouble of corrosion of underground structures often attributed to the stray currents from tramways. For the solution of the problem, electrical engineers and electrochemists must combine. For this reason the New York section of the American Electrochemical Society has accepted an invitation of the American Institute of Electrical Engineers to

hold a joint meeting on Friday evening, March 10, at the Engineering Societies Building, 29 West 39th Street, on the subject of corrosion. The principal speakers will be Dr. Burton McCollum, Bureau of Standards, Washington, D. C., for the American Institute of Electrical Engineers and Professor William H. Walker, Massachusetts Institute of Technology, Boston, Mass., for the American Electrochemical Society.

UNIVERSITY AND EDUCATIONAL NEWS

THE $1,800,000 of "University Building Bonds" voted by the people of California through approval of an initiative measure proposed by the alumni of the University of California, for additional building work on the campus at Berkeley, have been segregated by the regents of the university as follows: Benjamin Ide Wheeler Hall, a classroom building with a capacity of 3,500 students, its exterior to be of white granite, $700,000; completion of the university library, of which the present portion was built at a cost of $840,000, mostly defrayed by the bequest of Charles F. Doe, $525,000; second unit of the group of agricultural buildings, $350,000; first unit of a group of permanent buildings for chemistry, $160,000; new unit for the heating and power plant, $70,000; furnishings and equipment for the four structures first mentioned, $134,000.

THE contract for the new $60,000 chemistry building for Throop College of Technology was signed March 8, and the construction work was begun at once, the contract calling for the completion of the building in six months, which will be in time for the opening of the fall semester of 1916. This building is of reinforced concrete and hollow tile construction, and will consist of two stories and basement, and contain the research laboratories of Dr. Arthur A. Noyes, who will spend half of each year at Throop College, commencing next winter. The following appointments in the chemistry department for next year have recently been made, William N. Lacey, Ph.D., University of California, instructor in inorganic and industrial chemistry; Mr. James H. Ellis, of the University of Chicago and Massachusetts Institute of Technology, as research associate in physical chemistry, and Ludwig Rosenstein, Ph.D., of the University of California, who will become professor in inorganic chemistry.

THE Committee on Agriculture of the Massachusetts legislature has the full appropriation of $382,000 asked for new buildings this year by the Massachusetts Agricultural College.

MESSRS. COOLIDGE AND SHATTUCK, Boston, have been retained as architects for the new buildings of Lakeside Hospital and the medical school of Western Reserve University, and Mr. Abram Garfield, of Cleveland, for the new Babies' Hospital.

DISCUSSION AND CORRESPONDENCE

MESOZOIC PATHOLOGY AND BACTERIOLOGY

PALEONTOLOGISTS have not yet fully realized the possible value of geological evidences of disease to students of medicine. This may be due to the recent development of pathology and bacteriology or it may be due to the fact that the paleontology of the fossil vertebrates, especially, is still in a formative state. It is a fact, however, that paleontologists occasionally see objects from the early geological strata which show evidences of pathological or bacteriological activity. It would be of great value to those interested in medical subjects to have these objects discussed, since it would be of undoubted value to an understanding of the origin of disease.

Few attempts, so far as I am aware, have been made to bring to the attention of pathologists the earliest evidences of the occurrence of disease, although in the literature of paleontology one often finds figures of fossil bones showing "exostosial growths." Broken ribs, fractured limb bones, and injured vertebræ, a part or all of which show evidences of pathogenic conditions, are not uncommon. I wish in this place to plead for the proper discussion

of these objects, for in this way we may widen the scope and usefulness of paleontology.

The most notable advance, so far as I am aware, which has been made in this direction, is the work of B. Renault, who, in his large work "Microorganismes des combustibles fossiles"[1] has described and figured the bacteria, fungi and other pathogenic forms in the coprolites of fishes and in the coal of the Autun basin. I wish here to call attention to this really epoch-making work, with the thought that there might be others like myself, who were not aware of the existence of this important memoir. I am indebted to Mr. David White for calling my attention to this work and for loaning the volumes containing the memoir. The work is illustrated by 20 folio plates of untouched photomicrographs of bacteria, fungi, etc., and so conclusive is the evidence found there that no one can doubt Renault's conclusions. It is to the coprolites, or fossil feces, that the medical man would turn for evidences of disease and our author has figured and described in coprolites from the fishes of the Autun formations, many interesting colonies of bacteria, fungus growths, cultures of bacilli, organisms analogous to those producing caries of the teeth and many other important features of Mesozoic bacteriology. Some photomicrographs of fossil bone, obtained from the coprolites, showing the ravages of bacteria in the canaliculi, and bone corpuscles, are especially interesting.

So far as Mesozoic pathology is concerned the writer will describe and figure elsewhere a pathological growth involving two caudal vertebræ of a sauropodous dinosaur from the Como Beds of Wyoming. The original specimen belongs to the University of Kansas and I am indebted to Mr. H. T. Martin for the privilege of studying it. The growth looks remarkably like recent bone growths due to chronic osteomyelitis, or a bone tumor, or a callous growth possibly due to a fracture of the tail.

[1] *Bulletin de la Société de l'Industrie minérale Saint-Etienne*, Série III., 1899, Tome 13, pp. 865–1,161; 14 (1–2), pp. 5–159, 1900, with Atlas 1898–99, Pl. X.–XXV.; Atlas 1900–01, Pl. I.–V.

Williston[2] has figured the bones of the arm of a mosasaur showing pathological growth and synostosis of the carpals, possibly due to some infection. In the museum of the University of Kansas there is a mosasaur paddle showing extensive synostoses due either to disease or fracture.

It is interesting to note the possibilities open to paleontologists for the study of fossil remains. It is too early to say that a new field of research is opened up which will yield important results, but certainly such discoveries as may be made in this field of study will be of the greatest interest to those who are studying the activity and nature of modern diseases.

Roy L. Moodie
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Chicago, Ill.

EFFICIENT SUMMER VACATIONS

The late Mr. Taylor, efficiency expert extraordinary, once suggested that the pupils of technical schools be required to spend at least one year in commercial shop employment before they graduated. The opening, by Professor Riesman,[1] of the question of what to do with the summer vacation makes this an opportune time to suggest that the idea of compulsory practical experience is too good a one to go by default. But, three periods of three months each, in different plants and in positions of responsibility increasing with the growth of the student, seem to have many superior advantages and I venture to suggest the university control of its students during the summer period and a cooperation between educational and industrial institutions that shall furnish each student with a summer's work complementing that of the school year.

It should be as impossible as it is unnecessary for any student enrolled in a technical or scientific school to waste three months each summer. The graduates who go to work "in the South and Mid-Atlantic region" will not be excused by their employers from work during the summer because it is "out of the

[2] Geol. Surv. Kansas, Vol. IV., Plate LVI., Figs. 3 and 5, 1898.

[1] Science, February 25, 1916, p. 277.

question." Without detracting from the ultimate desirability of some such scheme as that proposed by Professor Riesman, may it not be more easy and advisable for us at once to adopt the principle of planning for the effective use of the summer vacation by all students in our technical schools, and of making three such periods a prerequisite for graduation? Our students will not be deprived of any more life, liberty and the pursuit of happiness than they will have to relinquish when they do graduate if we give them two vacation periods of approximately two weeks each, one immediately following the end of the school year, the other immediately preceding the next.

The chief objection to this scheme will come from those who want the summer for play—a class for whom we are not planning our college work—and those teachers who will claim that it is impossible to place the men. "Why?" "Oh, because industry doesn't want them." "Well then, train men who will be in demand; our best equipped institutions meet with little difficulty."

The scheme outlined has the merit of being the ideal toward which many of our institutions are even now striving, but complete success demands the wholeheartedness of combined effort and determination.

Lancaster D. Burling
Geological Survey of Canada

GERMAN GEOLOGISTS AND THE WAR

To the Editor of Science: Some idea of the terrible way in which the war is depleting the ranks of German men of science can be gained from a study of the lists of German and Austrian geographers and geologists enrolled in military organizations which have been published in the "Geologische Rundschau." These lists, which can be found in the numbers published on December 8, 1914, February 26, 1914 and December 14, 1915, combined with a short list in the November, 1915, number of *Der Geologe,* contain a total of 237 names. Of this total, 54 are reported killed and two missing and probably dead, a mortality of almost twenty-five per cent.

The number of the *Geologische Rundschau* just received (published on December 14, 1915), contains portraits and obituaries of three young German geologists who are well known to many of the profession in this country through their participation in the excursions and meetings of the Twelfth International Geological Congress held in Canada in the summer of 1913. They are Curt Alfons Haniel, privatdozent in geology and paleontology in the University of Bonn, killed in action near Laon on December 29, 1914; Siegfried Martius, assistant in the Mineralogical-Petrographical Institute at Bonn, fatally wounded at Ypres on October 23, 1914; and Adolf A. Riedel, a student just completing the work for his doctorate at Munich, a man of unusually attractive personality and of great intellectual promise, who was killed in northern France on November 21, 1914. Another participant in the International Congress, Dr. Wilhelm Paulcke, of Karlsruhe, has been reported wounded and the recipient of the Iron Cross.

A further indication of the serious character of the German losses is given by the statement of the last number of *Der Geologe* (November, 1915) that 75 of the personnel of the Royal Prussian Department of Mines had lost their lives up to April 1, 1915. This periodical also reports that Dr. Quitzow, editor of *Der Geologe* and *Der Geologen-Kalender* had not been heard from for a year, after being in action on the eastern front.

Walter L. Barrows
Trinity College,
March 14, 1916

SCIENTIFIC BOOKS

The Feebly Inhibited: Nomadism, or the Wandering Impulse, with Special Reference to Heredity: Inheritance of Temperament. By Charles B. Davenport.

The author argues that "all cases of nomadism can be ascribed to one fundamental cause —that those who show the trait belong to the nomadic race" made up of those possessed of the nomadic impulse. This impulse "depends upon the absence of a simple sex-linked gene that 'determines' domesticity." The data for the argument are family-histor-

ies, reported in the main by field-workers. Each individual is rated (by the author apparently) as nomadic or non-nomadic. From this point on, the argument concerns the explanation of apparent exceptions to expectation by the hypothesis, and of numerical divergences from the ratios expected by the hypothesis.

It seems to the reviewer that the technique of this and similar studies might easily be very much improved by having the individuals who are to be classified (for nomadism or neuroticism or intelligence, or whatever the quality may be), rated quantitatively and independently by, say, half a dozen competent persons. Where, as here, records of persons, not the persons themselves, are to be rated, this means of reducing errors in the rating is very easy to apply. Its importance consists in the fact that at least ninety-five per cent. of the mental traits which have been measured objectively show no signs of a multi-modal distribution; and that consequently the *a priori* chances are at least 19 to 1 that the strength of the nomadic impulse varies from a single mode at moderate amount up toward extreme nomadism and down toward extreme domesticity. To begin work by classifying men on the supposition that the strength of the nomadic impulse is distributed with one mode of nomads and one mode of home lovers seems therefore peculiarly unwise. If we can not have objective measurements we can at least use the average of a number of subjective ratings and have these made by a scale detailed enough to measure the nomadic impulse as probably stronger in a man who "is a wanderer and has left home repeatedly and been away for months at a time . . . does not like to stay in one place long; likes to bum and tramp around" than in one of whom nothing more nomadic is recorded than that he was "a stage-driver."

With respect to the inheritance of temperament, the hypothesis defended is that "There is in the germplasm a factor, E, which induces the more or less periodic occurrence of an excited condition (or an exceptionally strong reactibility to exciting presentations) and its absence, e, which results in an absence of extreme excitability. There are also the factor C, which makes for normal cheerfulness of mood, and its absence, c, which permits a more or less periodic depression. Moreover, these factors behave as though in different chromosomes, so that they are inherited independently of each other and may occur in any combination."

The author classifies individuals by their zygotic formulæ as choleric-cheerful, choleric-phlegmatic, choleric-melancholic, nervous-cheerful, nervous-phlegmatic, nervous-melancholic, calm-cheerful, calm-phlegmatic, calm-melancholic.

He assumes further that "there is typically a difference in the mood of a person with two doses or only one dose of a determiner; that two doses of the E factor produce the choleric temperament, while only one dose results in the nervous temperament; that two doses of the C factor result in a normal, cheerful state, while if only one dose is present the individual has a tendency to appear phlegmatic, and if C is wholly absent, to appear melancholic."

The argument concerns, of course, the closeness of the fit of the ratios found to those expected and the explanation of the apparently unconformable cases.

The difficulty of classification may be appreciated by the reader who will try to assign each of these cases to some one of the nine classes, have scientific friends do likewise and compare the results with Davenport's assignments.

1. Subject to sprees; suicided with poison.
2. Had acute mania; violent and destructive.
3. Sx.;[1] restless and twitches.
4. Surly and disagreeable; was hypererotic and brutal to wife and children.
5. Has a swaggering air and manner; ran away from home; put in a reform school for rape.
6. Wild and hot-tempered; profane and ugly towards his wife; takes whisky regularly to forget his business worries.
7. Jailed at 14 years for rape; hung himself.
8. Rough and uncouth; easily excited, passionate; has fits of temper.

[1] Sx. means unduly sexual.

9. Was Sx.; attempted to hang herself; flew into fits of temper; was slovenly, seclusive, indecent; at 32 had delusions of being poisoned; threw herself out of window.

10. Cut his throat with a razor.

11. Cut his throat as his father did.

12. Garrulous; jumps from one topic to another; has sudden emotional changes; said to have attempted suicide.

13. Had a nervous breakdown twice; is very hot-tempered; jumps from one topic to another.

14. An actress who is obstinate, irritable and passionate; after childbirth she became deranged and is now obstinate, silly and shameless; has attempted suicide.

15. A great talker; at 31 became violent, restless, noisy; developed delusions and hallucinations and threatened to commit suicide.

16. Contrary and stubborn; hyper-religious; became noisy, restless, sullen, had delusions.

17. Impulsive, irritable and passionate; became excited; attempted to shoot himself.

18. Quick-tempered; at 32 became excited; had acute mania.

19. Alcoholic, cross, irritable; at 37 threatened suicide; was excitable; had delusions and hallucinations.

20. Quick-tempered, had delirium tremens and hallucinations.

21. Sulky and impatient as a boy; drank; quick-tempered, homicidal and suicidal; has hallucinations and delusions.

22. High-tempered, extravagant; became insane and jumped out of window, killing herself.

23. At 20 became erratic, silly, irresponsible; wanted to travel and follow girls.

24. Obstinate, irritable and passionate as a child; became hysterical and tried to hang herself and kill her child.

These are a random half of his cases of the choleric-cheerful.

Is it not wise to delay acceptance of any simple Mendelian hypotheses for the inheritance of the strength of the tendencies to wander, to be excited, calm, elated and depressed, until the pedigree individuals are measured, or at least classified, by some criteria that are objectively definable? The reviewer welcomes the studies of the Eugenics Laboratory and appreciates the devotion that inspires them and the labor which sustains them. But he is left unconverted by each one —indeed, more confirmed in the faith, or fear, that human mental traits are due to a number of determiners or a variation in strength of the same determiner.

EDWARD L. THORNDIKE

TEACHERS COLLEGE,
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A Comparison of Methods for Determining the Respiratory Exchange of Man. By THORNE M. CARPENTER. 265 pp.

Energy Transformations during Horizontal Walking. By FRANCIS G. BENEDICT and HANS MURSCHHAUSER. 100 pp.

Physiology of the New-Born Infant. Character and Amount of the Katabolism. By FRANCIS G. BENEDICT and FRITZ B. TALBOT. 126 pp. Publications Nos. 216, 231, 233. Carnegie Institution of Washington, Nutrition Laboratory.

The study of the respiratory exchange of man has long been, and will doubtless long continue to be, one of the most fruitful fields of physiological investigation. Its value rests chiefly upon this fact of supreme importance: namely, that alike during rest and exercise, in health and disease, the method of indirect calorimetry as calculated from the respiratory exchange affords measurements of the energy expenditures of the body which are in close agreement with direct calorimetric determinations. Not only are the technical procedures of the indirect method far simpler and more generally applicable than are those of the direct method, but the former also afford a deeper insight into the sources of the energy than do the latter. Thus from a measurement of the volume of the air expired in a given time, and an analysis of its content of oxygen and carbon dioxide, we can determine accurately the amount and the character of the food stuffs consumed in the body. From such data are to be deduced the dietetic needs of the clerk and the stevedore, the bread cards of a blockaded people, the ration of the marching soldier, the food needed by the new-born infant, and the requirements of the typhoid patient. With such data we may meet more

effectively "the high cost of living." It is altogether probable also that during the next few years determinations of the respiratory exchange will be extensively introduced into routine clinical use.

For these reasons there is a special timeliness in the thorough study of the principal methods now in use for the determination of the respiratory exchange in man, offered by Carpenter in the first of the publications above listed.

In general such methods fall into two classes: those involving a closed circuit on the Regnault-Reiset plan, and those involving a so-called open circulation. As the most complete working out of the closed circuit method the apparatus devised by Benedict has been especially studied in its various forms in the work before us. With the results so obtained Carpenter has compared particularly as examples of the open circulation the Zuntz-Geppert method and the method of Tissot, of which that of Douglas is a modification.

In all forms of the Benedict apparatus the subject continually rebreathes from a closed system of chambers, pipes and absorbers in which the air is kept in circulation by a blower. The total carbon dioxide exhaled is absorbed and weighed; and the total amount of oxygen required to replace that absorbed by the subject from the system is determined either by weight or volume.

In the Zuntz-Geppert method the subject inspires the outside air through valves and a mouthpiece, and expires through a meter connected with a sampling device. From the meter reading and the analysis of the samples the total oxygen absorbed and carbon dioxide exhaled are calculated.

In the Tissot method the subject also inspires outside air, but expires into a carefully counterbalanced and graduated spirometer, from which a sample is later taken and analyzed.

In the Douglas method the expired air is caught in a bag from which it is later forced through a meter: the respiratory exchange being determined by the meter reading and the analysis of a sample.

Carpenter finds that with care and skill practically equivalent results are obtainable with the Benedict, Zuntz-Geppert, and Tissot methods. With the Douglas bag the discrepancies are slightly greater, although in this case also inconsiderable.

Although Carpenter reaches no positive conclusion as to the superiority of the features of any one of the general methods above described, he does point out that the ability of the investigator to perform accurate gas analyses is of special importance; and that apart from the gas analyses the Benedict method is more complicated than the Zuntz-Geppert, Tissot or Douglas methods. He especially emphasizes the fact that for purposes of gas analysis the apparatus of Haldane is by far the most perfect yet devised. He makes the excellent suggestion that as a check upon the accuracy of the experimental data analyses of pure air also should always be made and reported.

The reviewer leaves this work with a strong impression, although perhaps Carpenter himself would disclaim any intention of creating it, that the best method now available consists in the use of a spirometer of the Tissot type (or for special purposes a Douglas bag) and a Haldane analyzer. Great as have been the contributions of the Benedict apparatus, it appears inferior to this form of the open circuit, alike in theory, in the complexity of its manipulation, and in the cost of installation.

In "Energy Transformations during Horizontal Walking" Benedict and Murschauser describe the results obtained from a man walking upon a treadmill driven at various rates of speed. The energy expenditure of the subject in a post-digestive condition, standing absolutely still, is first determined. By subtracting this basal value from the figures obtained during walking they compute the extra energy expended in moving the body per kilogram and horizontal meter. For slow paces a distinctly uniform figure is obtained. This increases, however, with rapid walking, a point being reached at which the energy expenditure of running is less than that of rapid walking. It is shown that the high rate of energy ex-

penditure during rapid walking is largely due to the swinging of the arms. In running they find that a great part of the energy is consumed in the up-and-down motion of the body. They point out that the elimination of these factors is the line along which economy of energy is to be obtained.

In the "Physiology of the New-Born Infant" Benedict and Talbot include a translation of an important paper by Hasselbalch hitherto not generally accessible. Hasselbalch concludes that a well-nourished infant born at full term has a store of carbohydrates upon which it draws during the first few hours of life with a respiratory quotient well up toward unity. Thereafter for a time the respiratory quotient is lower and the metabolism approaches a fasting character. These striking results are not fully confirmed by Benedict and Talbot. Although in some cases they also find a decidedly high respiratory quotient, they suggest that it is due to an excessive blowing off of carbon dioxide during crying. They demonstrate the relatively great amount of energy which an infant expends in this exercise, and point out that even under normal conditions the mother never supplies sufficient nutriment to balance the infant's output during the first few days after birth. They emphasize the importance of keeping the newborn infant from crying, and so far as possible from any muscular exertion, in order to conserve its initial store of energy.

In the introduction to this work the authors complain of "a disposition on the part of some investigators to relieve us of the responsibility of interpreting certain of our results." The reviewer has not ascertained who these culprits are, or the extent of their fault. He is inclined to offer as a defense for them, however, that the one defect of the splendid publications which come from the Carnegie Nutrition Laboratory is that they are confined in most cases too largely to a statement of the methods and experimental results, without summaries or even emphatic textual indications of the opinions which the investigators themselves have reached. Most authors who write thus receive the just punishment of being unread. It is only for work of the highest order that the sentence is commuted to mere misinterpretation.

YANDELL HENDERSON

PHYSIOLOGICAL LABORATORY,
YALE MEDICAL SCHOOL

An Introduction to Neurology. By CHARLES JUDSON HERRICK. Philadelphia, The W. B. Saunders Company, 1915. Pp. 355, 137 figs.

This work is an example of marked success in the accomplishment of a difficult task. In dealing with such a subject as the nervous system it is probably easier to write a small book or a very large one than to produce a valuable one of medium size. One can write a short account of the mechanism, shirking the intricacies of its structure, and emphasizing what is picturesque and entertaining. Or, by taking more time, one can prepare a voluminous and impersonal account of it which shall serve for reference rather than consecutive reading. To write a book which shall be quite minute as to detail and yet concise and readable is a severer test of a man's scholarship and power.

The book in hand meets the requirement. The material is arranged with unusual skill and the presentation is masterly. The distinction is less in the freshness of the facts than in the selection made and the clarity of exposition displayed. Without indulging in digression or sacrificing accuracy the author has given his work a literary quality which is refreshing. There is a geniality about it all which to an exceptional degree establishes a rapport between writer and reader.

Without offering any objection to the author's choice of terms it may be in order to express regret that biologists can not agree upon the significance of the "sympathetic system." Professor Herrick makes it as inclusive as possible, that is to say, equivalent to the autonomic system of Langley. It seems clear that physiologists generally hold to the other conception, making the sympathetic the thoracico-lumbar autonomic. We commonly say that the heart is inhibited by the vagus and accelerated by the sympathetic fibers, yet

the vagus belongs to the sympathetic in the broader sense.

The figures used in the book are largely new and in all cases well adapted to illustrate the descriptions in the text. P. G. Stiles

SPECIAL ARTICLES

THE BOTANICAL IDENTITY OF LIGNUM NEPHRITICUM

The attention of the writer has just been called to the following criticism of his recent preliminary paper on *lignum nephriticum*, which appeared in *Nature*, Vol. 96, page 93, 1915.

> The most recent contribution to the history of *lignum nephriticum* is published in the *Journal of the Washington Academy of Sciences* (Vol. V., No. 14, August 19, 1915) by Mr. W. E. Safford. He gives the name *Eysenhardtia polystachya* (Ortega) Sargent, to the tree, and states that its botanical identity has remained uncertain until the present time. This statement, however, is scarcely correct, since the tree was referred to the genus *Viborquia* by Ortega, a name superseded by the later name of *Eysenhardtia* of Humboldt, Bonpland and Kunth. These authors correctly named the plant *E. amorphoides* in 1823, and Mr. Safford, following Sargent, merely restores Ortega's old specific name, *Viborquia polystachya*, making *Eysenhardtia amorphoides* a synonym of *E. polystachya*.

The above criticism is quite misleading. It is true that the species in question was described by Ortega in 1798; but Ortega drew his description from a shrub growing in the Royal Botanical Garden of Madrid, which had been propagated from seed sent to the garden from Mexico. He had no idea that the plant he described had any connection with the classic *lignum nephriticum;* he did not know its Mexican name; indeed he was unaware that it might attain the dimensions of a tree. Humboldt, Bonpland and Kunth were likewise unaware that the plant described by Kunth as *Eysenhardtia amorphoides* was the source of *lignum nephriticum*, or that its wood would yield a fluorescent infusion. That its identity with the latter was unknown is shown by the definite statement of Sargent, when establishing the combination *Eysenhardtia polystachya*. Referring to *Eysenhardtia* he says:

> The wood of some species is hard and close-grained and affords valuable fuel. The genus is not known to possess other useful properties.[1]

If the species described first by Ortega as *Viborquia polystachya* and later by Kunth as *Eysenhardtia amorphoides* was known to be the source of *lignum nephriticum*, a classic wood remarkable for the fluorescence of its infusion and at one time famous throughout Europe, why would not these authors have called attention to its identity?

The first to indicate its botanical identity, as the writer pointed out in his paper cited above, was Dr. Leonardo Oliva, professor of pharmacology in the University of Guadalajara (1854), but his identification was not accepted by subsequent authorities. Oliver and Hanbury, in the "Admiralty Manual of Scientific Inquiry" (page 391, 1871), call attention to the wood as follows:

> *Lignum nephriticum.*—This rare wood, noticed by some of the earliest explorers of America, is a production of Mexico. To what tree is it to be referred? Its infusion is remarkable for having the blue tint seen in a solution of quinine.

In the third edition of the "Nueva Farmacopea Mexicana" (page 153, 1896) the statement is made that *leño nefritico* had been erroneously attributed to *Varennea polystachya*, or *Eysenhardtia amorphoides* H. B. K., but that its classification was not known. Dragendorf in his well-known Heilpflanzen (page 345, 1898) refers it to the genus Guajacum:

> Das Lignum nephriticum der älteren Medicin wird wohl von einer Guajacum-Art stammen.

Dr. Otto Stapf, to whose historical paper on *lignum nephriticum* published in the "Kew Bulletin of Miscellaneous Information" (pages 293–305, 1909) the writer has already referred, experimented with a piece of wood from the Mexican collection in the Paris Exposition, bearing the label "Cuatl." Dr. Stapf referred this wood to *Eysenhardtia*

[1] Sargent, C. S., "The Silva of North America," Vol. 3, p. 30, 1892.

amorphoides, but his specimen was not accompanied by botanical material which would serve to establish its identity with certainty, and a later investigator, Dr. Hans-Jacob Möller, of Copenhagen, who also made an exhaustive study of the wood from historical and pharmacological standpoints, failing to find fluorescence in specimens of *Eysenhardtia* wood sent to him from Mexico ("das Kernholz von einem recht dicken Ast," which yielded "keine Fluoreszenz") arrived at the conclusion that the mother-plant of *lignum nephriticum* must be a Mexican species of *Pterocarpus.*[2]

The conflicting conclusions of Dr. Stapf and Dr. Möller, assigning *lignum nephriticum* to mother-plants of two distinct genera, caused the writer to continue his researches as to the origin of this classic wood, the botanical identity of which he had been seeking to establish for more than twenty years. Specimens of wood accompanied by botanical material sufficient to identify it with *Eysenhardtia polystachya* came into his possession in 1914 and led to the publication of his paper "*Eysenhardtia polystachya,* the source of the true *lignum nephriticum Mexicanum,*" in the *Journal of the Washington Academy of Sciences,* in August, 1915. Certain discrepancies, however, in the early accounts of *lignum nephriticum* caused him to pursue his investigations still farther.

Dr. Stapf assumed that the *Palum Indianum* of which Johannes Bauhin's cup was made, "almost a span in diameter and of unusual beauty," with chips of the same wood of a reddish color, and the "white" wood yielding an infusion like pure colorless spring water, of which Athanasius Kircher's cup was made were both identical with the dark-colored wood used by Robert Boyle in his historical study of fluorescence. A further source of confusion was Hernandez's account of the logs of *lignum nephriticum* carried to Spain, specimens of which he declares he has seen "larger than very large trees." Bauhin's figure of his wood does not in the least suggest the wood of *Eysenhardtia polystachya,* but does resemble the wood of *Pterocarpus indicus* of the Philippine Islands.

We have an authentic account of the manufacture of cups from this Philippine wood and of their medicinal use, exactly as described by Bauhin and Kircher, written by Father Delgado, who, when a boy in Cadiz, was given fluorescent water to drink from one of them, as a remedy for a certain malady, and who afterwards saw the cups in southern Luzon. Delgado identifies the wood of which these cups were made as that of the Philippine *naga* or *narra* (*Pterocarpus indicus*), a tree of great dimensions, yielding logs of large size, many of which were undoubtedly carried to Spain by way of Mexico at a very early date. Of this wood there are two recognized varieties, one pale colored, locally designated as "female," the other of a reddish color, called "male" narra. From the first of these was evidently carved the cup described by Kircher; from the second the cup presented by Dr. Schopff, physician to the Duke of Würtemberg, to Bauhin.

Very distinct in texture and appearance from the wood of the Philippine *Pterocarpus indicus* is that of the Mexican *Eysenhardtia polystachya.* Moreover, the latter species never attains the size of a tree capable of yielding large logs. It must also be noted that there is no record of a single cup made of its wood. A search for such cups in Mexico has been futile, while cups made of *Pterocarpus indicus* were common in the Philippines at the time when Delgado wrote. They could only reach Spain by way of Mexico, and they might easily have been thought to be of Mexican origin. Delgado was a Jesuit and it was from the *Procurador* of the Jesuits in Mexico, that the Jesuit Kircher received the cup described by him.

A full account of the two woods known as *lignum nephriticum,* illustrated by colored plates, will appear in the Smithsonian Report for 1915.

W. E. SAFFORD

BUREAU OF PLANT INDUSTRY,
February 2, 1916

[2] *Berichte der deutschen Pharmaz. Gesellsch.,* Vol. 23, pp. 88–154, 1913.

PRELIMINARY STUDIES ON HEATED SOILS

A FAIRLY extensive amount of data has been accumulated upon the immediate changes induced in soils heated to temperatures between 50° C. and 500° C., with reference to the effect of such treatment upon seed germination and plant growth. The results appear to have some value in explaining the striking effects, injurious and beneficial, observed on sterilized or partially sterilized soils. The work of Russell[1] and his associates, Pickering[2] and Schreiner and Lathrop[3] have led in general to quite different conclusions as regards the nature of the injurious action. These and other workers have also maintained considerably different views regarding the nature of the beneficial action of sterilized soils. The difference in opinion is perhaps due in a large measure to the point of view from which the investigation has been undertaken, as well as to the manner in which the sterilization of the soil has been accomplished. The conclusions drawn here are considered to apply particularly to soils heated above 100° C., although it is believed that the same principles apply in soils heated to lower temperatures. An endeavor has been made to give due consideration to the several phases of the subject since these involve not only chemical, biological and physical changes in the soil, but also the physiological and pathological conditions of the seeds and plants grown in these soils.

The method of investigation by which the results presented in this paper were obtained has been largely that of attempting to correlate the chemical changes produced in the heated soils with their effect upon seed germination and plant growth. The amount of water-soluble material formed by heating has been measured by the lowering of the freezing point. For this the Beckmann thermometer was used. Ammonia was determined by the ordinary method of distilling in the presence of magnesium oxide. The nitrate was determined colorimetrically by the phenoldisulphonic acid method. Seed germination tests were made on the soil in Petri dishes. The seeds were placed on the surface of the soil, which was almost saturated with distilled water. Various kinds of seeds were employed, but especial use was made of cabbage.

The results in general were similar for the different seeds, though they varied much in their susceptibility to the injurious action. Lettuce and clover seeds, for instance, were very susceptible to the injurious action of highly heated soils, whereas rye and buckwheat were very resistant. Plant growth is affected in much the same manner, wheat, for example, recovering rapidly from the deleterious action of certain heated soils where tomatoes appeared to be permanently injured. Different soils give markedly different results upon heating to the same temperatures. The action appears to be dependent particularly upon the content of organic matter in the heated soil, as this influences both the amount of decomposition and the absorptive power of the soil for the substances produced upon heating. These results are in general confirmatory of the work of others upon this subject.

The temperature to which the soil is heated is seemingly the most important factor in determining the extent of the injurious or beneficial action. Approximately 250° C. was found to be the most critical temperature in all the soils used. At this temperature seed germination was most strikingly retarded. Early plant growth was usually checked for the longest period of time on soils heated to 250° C., although late plant growth, in the case of some crops at least, was most vigorous on these soils. Heating to temperatures of 300° C., or above, in all the soils used, again reduced the injurious action to seed germination and early plant growth, as well as the beneficial action to late plant growth.

Heating soils to 250° C. produced greater amounts of material extractable with water than heating to higher or lower temperatures. The ammonia content of the soil increased proportionally to the temperature of heating up to about 250° C., after which it rapidly

[1] Russell and Petherbridge, *Jour. Agr. Sci.*, 5: 248–287, 1913.

[2] Pickering, *Jour. Agr. Sci.*, 3: 277–284, 1910.

[3] Schreiner and Lathrop., U. S. Dept. Agr., Bur. Soils Bul. 89, pp. 7–37, 1912.

fell to a minimum. The increase in ammonia was accompanied by a decrease in nitrates, which were practically non-existent in the highly heated soils.

The ammonia produced on heating soil has been suggested by Russell as causing the injurious action, although no evidence on this point could be obtained. Pickering suggested that the injurious factor was volatile in nature, on account of its gradual disappearance from the soil, but Russell disagrees on this point. Russell, however, worked with low temperatures, usually not exceeding 100° C., and with volatile antiseptics. Under such treatment, only relatively small amounts of ammonia are produced directly, and seed germination and plant growth are not so strikingly affected as in soils heated to higher temperatures.

The percentage of seed germination has been found to be closely correlated with the amount of ammonia present in the heated soils studied. The amount of ammonia required to injure germination, however, appears to vary with the type of soil when comparisons of different heated soils are made. It appears that the absorptive power of the soil is a very important limiting factor in determining the extent of the injurious action.

The presenec of dihydroxystearic acid as described by Schreiner could not be demonstrated in the most toxic of the heated soils. That the toxic substance is of a volatile nature is evident by the fact that it is readily removed from the soil by aeration. If collected in water upon removal, its toxicity can be readily demonstrated. By collecting in a hydrochloric acid solution the chemical composition of the resultant salt has been shown to be ammonium chloride, containing ammonia in sufficient quantity to account for the toxic action of heated soils.

It is improbable that all the ammonia produced in heated soils exists as free ammonia. Large amounts of carbon dioxide are also produced when soils are heated, which possibly accounts for the increased acidity of heated soils. The evidence at hand points toward the formation and injurious action of ammonium carbonates particularly. These salts being unstable in the soil except when kept in a dry and unaerated condition, accounts for the gradual disappearance of the injurious action of heated soils. It also appears that other compounds of ammonia are formed which are more stable in character.

The beneficial action of heated soils on plant growth, especially of those heated between 150° C., and 250° C., is believed to be due in a large part to the direct assimilation of ammonia or ammonium compounds by the plants after the manner described by various workers. The increased growth follows in practically all cases after a period of injurious action to plant growth, and is no doubt dependent upon the reduction of the toxic substance to a point where it is stimulatory or acts as a plant food. The relative importance of increased plant food production as a result of bacterial activity, and of direct chemical action, in highly heated soils remains to be ascertained.

The writer will be pleased to obtain suggestions or criticisms on the point of view presented in this paper.

James Johnson

University of Wisconsin

NOTE ON THE INTERFERENCES OF PARALLEL AND CROSSED RAYS

After perfecting the design (Fig. 1) of my last article[1] thus obtaining an apparatus which is free from transmission through glass and in which all the rays are guided by reflection from metal surfaces only, I have secured definite evidence showing that the strands of interference patterns obtained are actually referable to the intersection of two grids, due to the two sodium lines, respectively. One of the grids is retarded in rotational phase with respect to the other. Why in the case of a transmitting grating, the nature of the phenomenon is so effectively concealed, I have not been able to make out; but with mercury light, but one set of striations is obtained, as anticipated.

With this definite understanding of the phenomenon, the resolving power works out as

[1] Science, February 25, p. 282.

$$d\lambda/\lambda = D\, dh/R\sqrt{D^2-\lambda^2}$$

where D is the grating space, R the path length and dh the displacement of the second grating G', normally to itself, between like rotational phases of the two sodium lines. The second member of the equation is roughly dh/R and if $dh. = .003$ cm. is still guaranteed and $R = 300$ cm. as in my apparatus, the limiting resolving power is $d\lambda/\lambda = 10^{-5}$ or .06 *A. U.* If $d\lambda/\lambda = 10^{-3}$ for the two sodium lines, $dh =$ .3 cm., which is about what I found.

An interesting application of the apparatus (Fig. 1) or the other similar types may be suggested. By half silvering the mirrors and providing a similar set *beyond* them, there should be no difficulty of bringing the interferences due to crossed rays, and to parallel rays, into the field of the telescope, *together*. Strictly homogeneous light (mercury arc) would be needed to obviate the duplications of the sodium arc. In such a case, therefore, the parallel fringes could be used after the manner of a vernier on the crossed fringes. One might think of this with a view to a repetition of the experiment of Michelson and Morley, if this experiment had not been so thoroughly carried out by the original investigators. However, the plan would be to rotate the apparatus, as a whole, so that the two crossed rays would be alternately in and at right angles to the earth's motion, whereas the two parallel rays would preserve the same relation to that motion. Naturally the parallel and crossed paths would in such a case have to be enlarged by multiple reflection. Another favorable feature of the reversed spectrum interferometer is the small displacement, x, of micrometer per fringe. This is $x = \lambda/2(1+\cos\theta)\cos\sigma/2$, θ being the second angle of diffraction, σ the sum of the two. Hence roughly $x = \lambda/4$, or the sensitiveness is about twice that of the customary types of apparatus.

Carl Barus

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SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

The 107th regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club, at 8 P.M., Tuesday, November 2, 1915. Forty-five members and six guests were present. The following papers were presented:

Relation of Catalase and Oxidases to Respiration in Plants (with lantern): Chas. O. Appleman. (To be published in full as bulletin number 191 of the Maryland Agricultural Experiment Station.)

The chemical mechanism of respiration in plants is very complex and imperfectly understood. Enzyme action undoubtedly plays the most important rôle. Among the enzymes which have been assigned various functions in respiration, we find the oxidases and catalase, although their relation to this process is almost entirely hypothetical. Respiration in potato tubers is not only greatly accelerated by various artificial treatments, but is subject to fluctuations under natural conditions, such as greening and sprouting. The rate of respiration also varies in different parts of the same tuber and tubers of different varieties. Since these tubers also contain very active catalase and oxidase, they were chosen as specially favorable material to make a quantitative study of the relation of both catalase and oxidase activity to the intensity of respiration. The data seem to justify the following conclusions:

1. The oxidase content in potato juice gives no indication of the intensity of respiration in the tubers. In other words, there is no correlation between oxidase activity and the rate of respiration in these organs. The author does not disclaim any rôle of the demonstrable oxidases in respiration, but they certainly are not the controlling factor in regulating the rate of respiration in potato tubers.

2. Catalase activity in the potato juice shows a very striking correlation with respiratory activity in the tubers.

Some Philippine Botanical Problems: E. D. Merrill.

To be published in full elsewhere.

Botanical Notes of a Trip to Japan: W. T. Swingle.

To be published in full elsewhere.

The 108th regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club, at 8 P.M., Tuesday, December 7, 1915. Thirty-two members and three guests were present. Messrs. A. T. Speare, James Johnson, H. R. Rosen and H. C. Rose were elected

to membership. The following papers were presented:

Dr. W. Ralph Jones: An Appreciation: DR. C. L. SHEAR.

Dr. Jones was quiet and retired in disposition and of excellent habits. He had a great aversion to taking animal life and would not take courses in zoology involving the death of higher animals; neither would he hunt nor fish. His chief recreation and amusement were novel reading and music. He was very fond of reading good French novels in the original, and of the opera. He showed an interest in natural science early in life and as a boy began a collection of minerals and also an herbarium of flowering plants. His interests in botany were broad and his training in languages, chemistry, physiology, etc., were such as to give a broad and substantial foundation for research. He possessed three of the fundamental requirements for success in scientific work, that is, love for truth, combined with thoroughness and accuracy. His notes, drawings and manuscripts were models of neatness and accuracy. He had undertaken several lines of investigation in connection with blackberry, currant and gooseberry diseases, but had practically completed only one of these. This was a study of what appears to be a new species of *Thielavia* isolated from diseased dewberry plants. It is to be deeply regretted that a man so well equipped by temperament and training for research should be cut down in the prime of life and usefulness.

Experimental Study of the Life Duration of Seeds (with lantern): DR. WM. CROCKER.

To be published in full elsewhere.

Notes on Variations in Chinese Chestnuts (specimens): P. L. RICKER.

To be published in full elsewhere.

THE 109th regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club at 8 P.M., Friday, January 14, 1916. Seventy members and five guests were present. Messrs. Rodney B. Harvey, G. McMillan Darrow and Roland McKee were elected to membership.

Economic-Botanical Exploration in China (with lantern): FRANK N. MEYER.

Mr. Meyer, an agricultural explorer of the United States Department of Agriculture, has spent nine years in China and adjoining countries studying the flora of this region and searching for plants of economic value for introduction into the United States. He found quite recently a hickory in China which has never been recorded in botanical literature. As yet no sycamores nor any papaw (*Asiminia triloba*) or leather-wood (*Dirca palustris*) have been found in China. Field work in botany in China is extremely difficult because most of the wild vegetation near densely settled parts has been exterminated. However, Buddhist and Tavist priests have preserved many specimens in their temple compounds. Mr. Meyer made reference to the discovery of the wild peach in the provinces of Shansi, Shensi and Kansu, and to the expertness of Chinese gardeners in grafting. He expressed the opinion that in this country there is great need of national arboreta and permanent botanical collections.

The Recent Outbreaks of White Pine Blister Rust: DR. PERLEY SPAULDING.

When this disease first reached this country, it was thought repeated annual inspections of the lots of diseased trees would soon result in the complete eradication of the disease. Our experience since that time, together with increasing knowledge of the characteristics of the disease, shows us that this is not true. Apparently the only method of completely eradicating this disease in any lot of infected trees is that of total destruction of that lot. While large numbers of plantings of diseased imported trees were made in 1909, the careful inspection work done since that time by the states has kept the disease in them almost completely in control. It has become increasingly evident that our great danger lies in lots of diseased trees which were imported before 1909. These in most cases we know nothing about and of course have not been able to give them the necessary inspection. In the years 1909 to 1914, inclusive, there were eleven outbreaks of this disease, that is, cases where it escaped from the diseased pines on to neighboring currants or gooseberries. In 1915 the weather conditions were so favorable for the disease that it spread very readily and for relatively long distances. Last year twelve outbreaks occurred. These areas vary in extent from only a few currant or gooseberry bushes up to a single area of some 400 or 500 square miles. Experiments have shown that the wild currants and gooseberries of the Pacific coast and Rocky Mountain regions are susceptible to it. In fact it may be stated that all species of currants and gooseberries, so far as they have now been tested, are susceptible. The ordinary cultivated black currant, *Ribes nigrum*, however, is far more susceptible than any other species. While it

is not grown in large quantities, it is very widely scattered; enough so that the disease during the past season readily spread upon this single species for miles. The future of the white pine, which has been quite largely depended upon for the forests of the northeastern states, is very seriously threatened by this disease, unless efficient efforts are made to control it. The character of this fungus is such that the removal of all wild and cultivated currants and gooseberries from the affected areas will stop its further spread in those areas. If the cultivated black currant could be eliminated from the nursery trade so that it would not be sold and its use could gradually be discontinued everywhere within the affected states, a great step would be taken toward the control of this disease. But more than this, state officers must have absolute power to destroy diseased pines and currants and gooseberry bushes, in order that unanimous action can be carried out within these affected areas. With this power should also be given the power to declare and enforce quarantines against shipments of stock from other states. When compared with minute search which is required in finding gypsy and brown-tail moth nests in southern New England, the search for wild and cultivated currants and gooseberries is comparatively simple. It also is comparatively easy to carry out when compared with the climbing of trees 75 to 100 feet in height in certain sections of New England for the removal of brown-tail moths' nests, as is done every year. An efficient fight against this disease even now is not impossible, but it very shortly will be if not started at once.

Catha edulis: A Narcotic of the Southern Arabs (with specimens): Paul Popenoe.

The kat, Arabic *qat*, shrub is a native of Africa, but much cultivated in Yaman, where its use is increasing so that the town of Aden now consumes annually more than 2,000 camel-loads of the leaves and twigs, which are chewed for their stimulating properties. The plant contains small quantities of an alkaloid called *katrine*, which seems to resemble cocain. It has been introduced into the United States by the Office of Foreign Seed and Plant Introduction, United States Department of Agriculture, and grows well in the South. The dangers from its use have probably been much exaggerated. This plant may present commercial possibilities as the source of a new beverage to compete with tea.

W. E. Safford,
Corresponding Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 550th regular meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, February 12, 1916, called to order at 8 P.M., by President Hay.

Fifty persons were present.

On recommendation of the council Walter P. Taylor, Museum of Vertebrate Zoology, Berkeley, California, was elected to active membership.

Under the heading Brief Notes and Exhibition of Specimens, Dr. Howard called attention to the work lately done by Dr. W. V. King, of the Bureau of Entomology, in demonstrating that *Anopheles punctipennis* was a carrier of both tertian and estivo-autumnal malaria parasites. He exhibited lantern slides of this mosquito and photo-micrographs of the stages of the malaria organism in this hitherto supposedly harmless species of mosquito.

Under this same heading W. L. McAtee gave some of his recent observations on the vegetation in Virginia in the region south of Washington.

The first paper of the regular program was by Henry Talbott: "Nepigon." Mr. Talbott gave an entertaining account of a trip made by himself and others to Lake Nepigon. The fishes of the lake and neighboring region were especially dwelt on. Mr. Talbott's paper was discussed by Dr. Howard.

The second and last paper of the regular program was by Vernon Bailey, "Game and Other Mammals of the Yellowstone Park Region." Mr. Bailey gave a short outline of his itinerary on a recent trip through the Yellowstone Park and the neighboring region, particularly to the south. The ground covered was mainly off the tourist track. The speaker described the beauties of the park from the viewpoint of the lover of wild life; he called particular attention to the loss of fear of men by wild life when protected from guns, dogs and cats; he called to notice the thriving condition of herds of ruminants in the park and the successful efforts now made to supply hay to the needy in winter, and to keep the antelope from wandering out of the park. Mr. Bailey's communication was profusely illustrated with lantern slide views of the park and its wild life, in especial, the white-tailed deer, mule deer, elk, moose (recently described as *Alces shirasi*), antelope, bison, some of the smaller mammals, and Canada geese.

M. W. Lyon, Jr.,
Recording Secretary